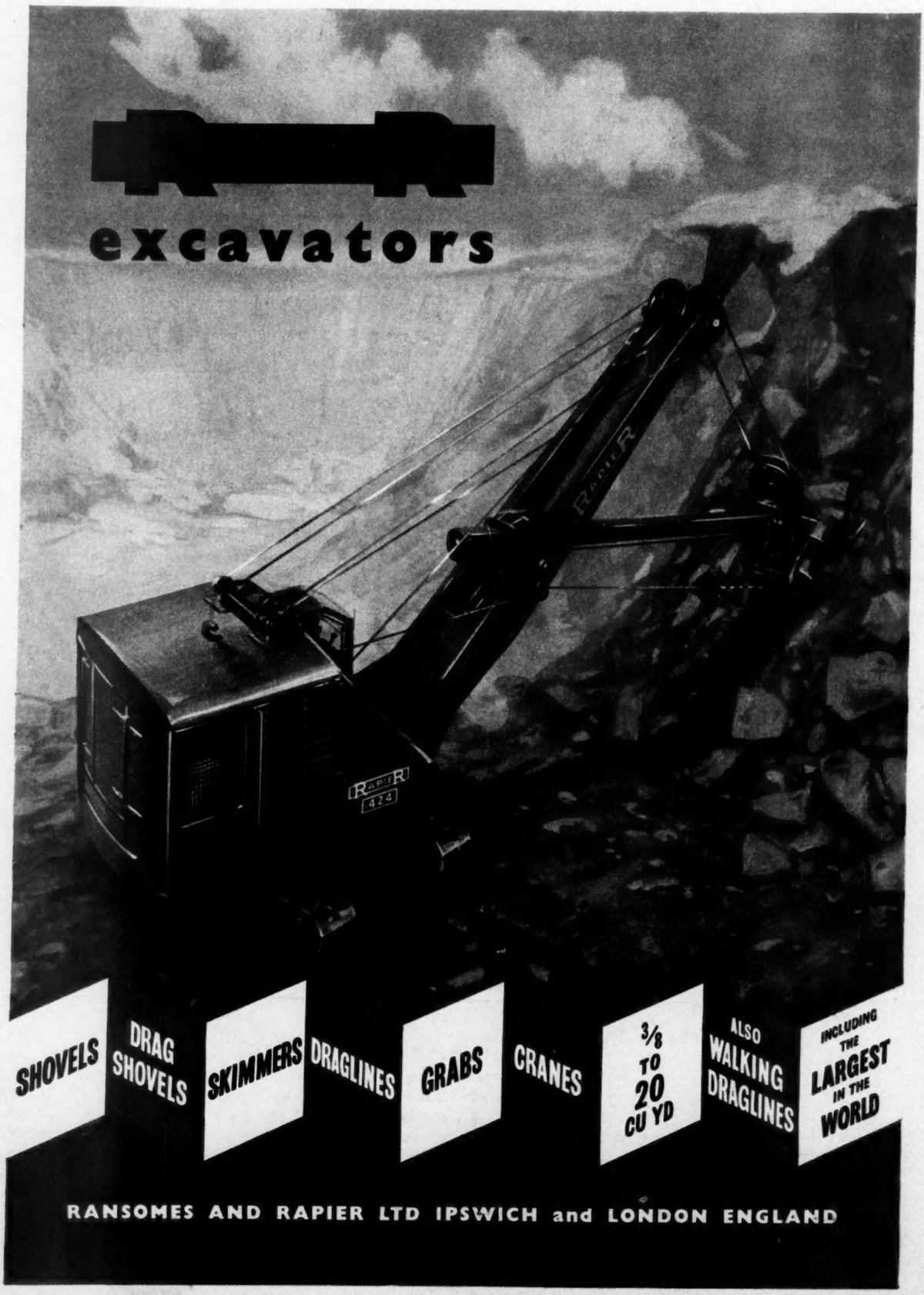
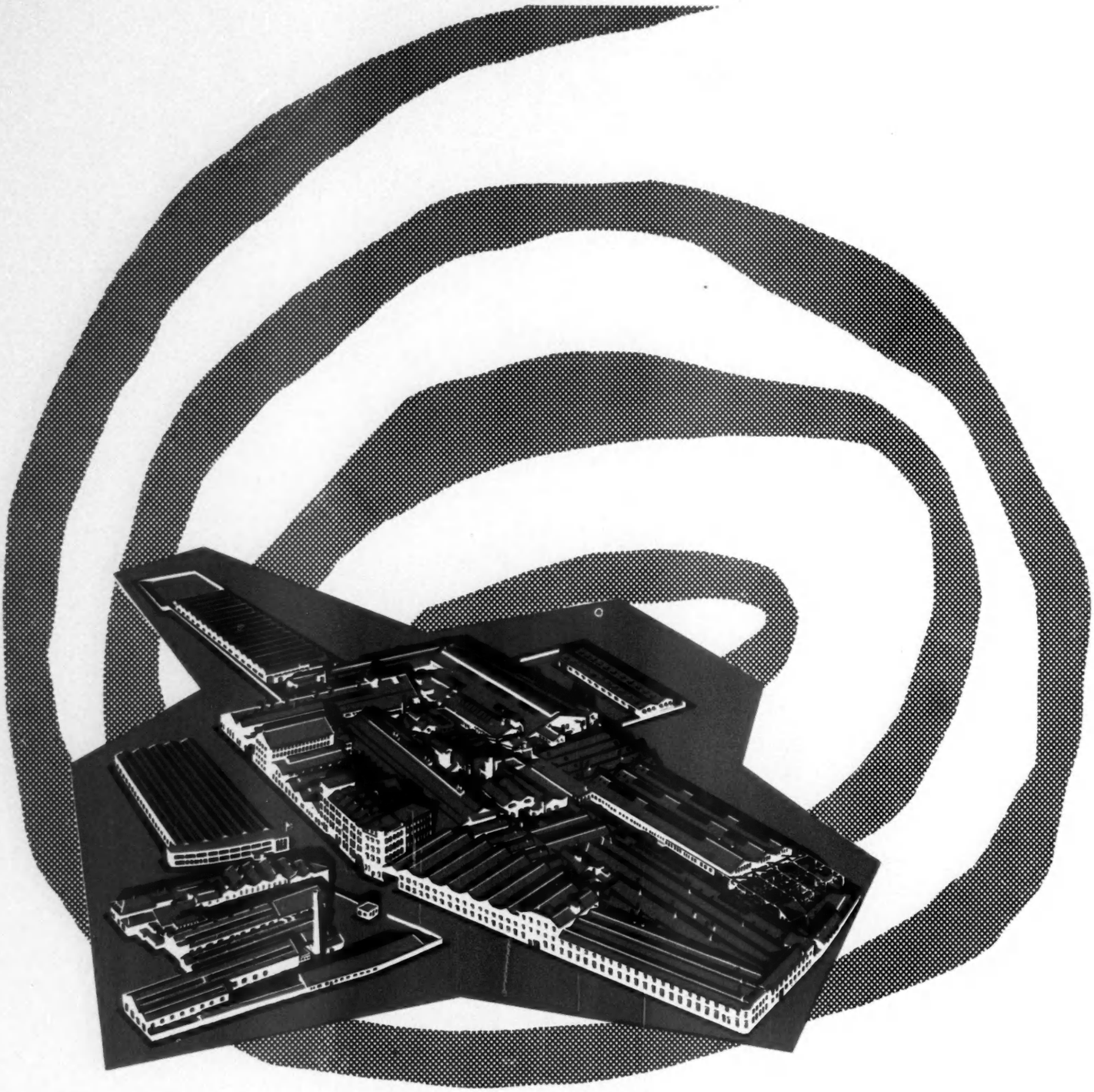
The Engineer

JULY 11, 1958 28 ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS





power for productivity

up-to-date products from modern factories: *Clutches, Conveyor Drives, Couplings of all types, Double helical gear units, Fabricated steelwork, Geared motors, Hydraulic couplings, Iron, steel and non-ferrous castings, Machine-cut gears of all types, Motorised rollers, Patent Taper-flushbushes, Plummer blocks, Shaft-mounted gear units, Special machinery drives, Spiral bevel gear units, Turbine gears, V-Rope Drives, Variable speed drives, Worm reduction gears.*

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

Head Office: Thornbury • Bradford 3 • Yorkshire

Phone: 65251 (20 lines) Grams: "Crofters Bradford Telex," Telex 51186

THE ENGINEER

Established 1856

No. 5346 JULY 11, 1958 VOL. 206

EDITORIAL CONTENTS

Leading Articles	Setting the Seal on Windscale	41
	Charles Dickens and Technical Education	41
	Comprehensive List of Engineering Relics	42
	The Navy Loses Six More Carriers	42
	Air Registration Comes of Age	43
Articles		
	100 Years Ago	43
	North of Scotland Hydro-Electric Schemes. No. IX. (Part I)	44
	Nuclear Reactor Dynamic Analysis. No. I	46
	The Final Fleck Report on Windscale	47
	Progress at Hunterston Nuclear Power Station	51
	Large Electricity Supply Systems. No. V	54
O. S. Nock	Performance and Efficiency Tests on the 3300 h.p. " Deltic " Locomotive	60
	Power for a Sugar Refinery	63
	Blowdown Tunnel	64
	High-Speed Metal Removal	65
	Seventy-Five Years in Telecommunications	66
	Anglo-American Agreement on Atomic Energy	67
	Air Registration Board	67
	Parking Experiments	67
	Works Reconstruction Scheme	67
	Placer Dumpers	68
	Structural Engineeers' Conference	68
	Suspension Bridge at Samawa, Iraq	68
	Small Power Rolling Mill	68
	Training for " Hollerith " Equipment	69
	Boiler Scaffolding	69
	Radial Drilling Machine	69
	Joint for Cast Iron Pipes	69
Continental Section		
	Twelfth Achema Congress and Exhibition. No. I	71
	International Gas Turbine Congress	73
	Automatic Camera Microscope	74
	Automatic Packing Machine	74
American Section		
	Ten Years of Transistor Progress in the United States. No. I	75
LETTERS	A " Tiddley " Budget	58
	Industry Fights Corrosion	58
BOOK REVIEWS		58
NEWS AND NOTES	Industrial and Labour Notes	70
	Personal and Business	78
	British Patent Specifications	79
	British Standards Institution	79
	Launches and Trial Trips	80
	Forthcoming Engagements	80
	Advanced Engineering Courses	80

INDEX TO ADVERTISERS : PAGE 139 **CLASSIFIED ADVERTISEMENTS : PAGE 130**

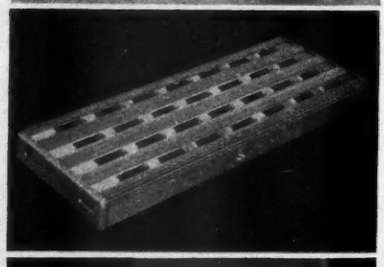
NOTICE TO READERS No undertaking can be given to return illustrations or manuscripts. Correspondents are requested to keep copies. No notice is taken of anonymous communications.

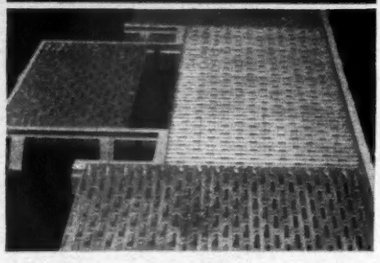
SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 7s. 6d. each. Postage 1s. 9d. extra.

Published every Friday by
MORGAN BROTHERS (PUBLISHERS) LTD., at 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone: CENtral 6565

Head in the clouds

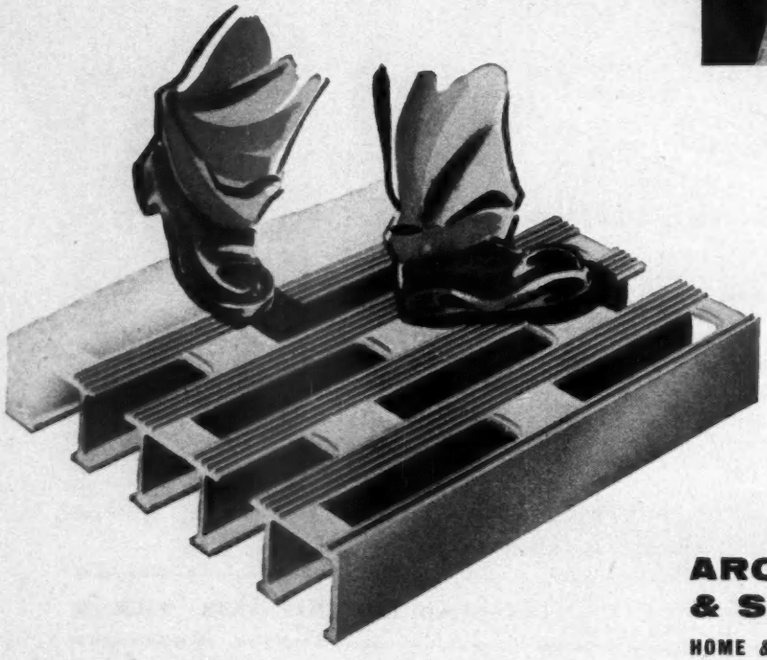




Down-to-earth industrialists have been quick to install Alaflor extruded aluminium flooring. It's outstanding economy and safety cannot be ignored.

Strength and rigidity, in combination with minimum weight and the non-corrosive properties of this aluminium alloy, make maintenance overhead a thing of the past. For safety, Alaflor cannot be bettered, it's spark-resistant and non-skid.

Put Alaflor underfoot for saving and safety's sake.
Literature is available on request.



or feet on ALAFLOR

NOTE: Alaflor is manufactured in 6in. widths and extruded to a maximum length of 24ft. Grating depths from $\frac{3}{4}$in to 2in. Available in two types (a) Rectangular (illustrated), size of punch 3in. × $\frac{1}{2}$in.(b) Square, size of punch $\frac{1}{2}$in.

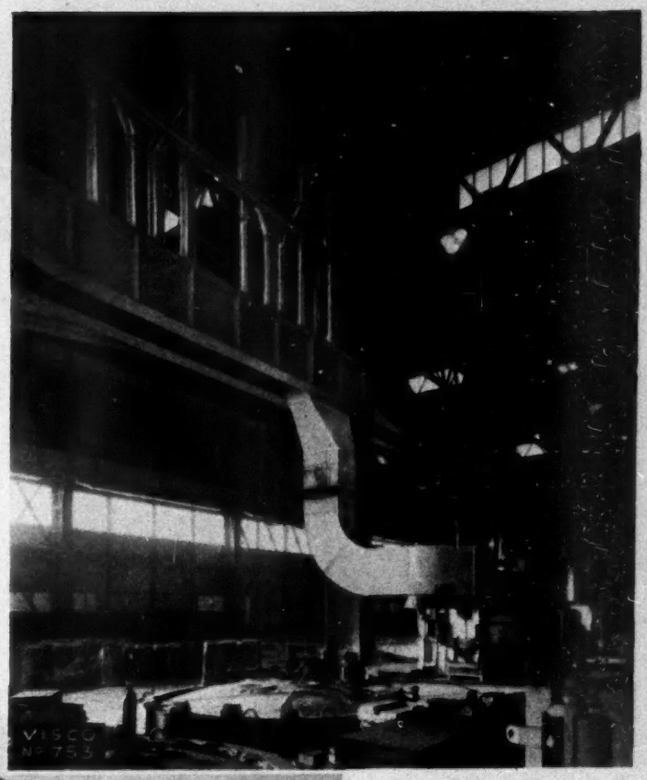
ARCHIBALD LOW & SONS LIMITED

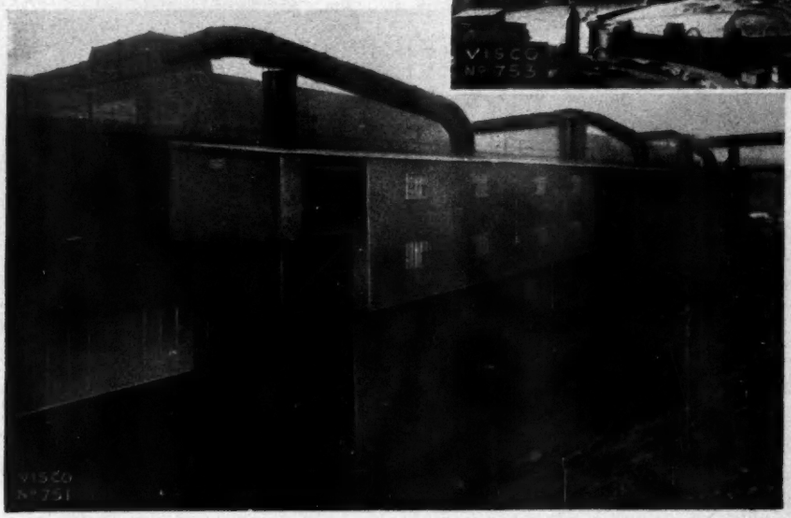
HOME & OVERSEAS SALES OFFICE:
143 Sloane St., London S.W.1. Tel: Sloane 6178

HEAD OFFICE & WORKS: 82 Merkland Street
Partick, Glasgow W.1.

VISCO

combined
FUME REMOVAL & DUST RECOVERY PLANT for Samuel Fox & Co. Ltd.





Interior of
One of two "Birlec" Arc Furnaces equipped with Visco Fume Removal Plant (side elevation showing exhaust hood mounted on furnace roof) at the works of Samuel Fox & Co., Ltd., Sheffield.

Exterior of
Six "Visco-Beth" Automatic Dust Collectors with protective housing at the works of Samuel Fox & Co., Ltd., Sheffield.

The two Birlec arc furnaces recently installed in the melting shop at the Stocksbridge Works of Samuel Fox & Co., Ltd., are equipped with Visco Combined Fume Removal and Dust Recovery equipment.

These furnaces form an installation which is one of the largest of its kind in Europe and have a combined capacity of 3,000 ingot tons of alloy steel each week of approximately 140 hours operation.

The enormous volume of fume generated, especially during the lancing process, containing finely divided ferric-oxide and other solids is induced into heavily constructed hoods fitted to the furnace roofs. It is then conveyed through ducting to "Visco-Beth" Automatic Dust Collectors where the solid matter is trapped. This is stored temporarily for later disposal and the filtered air discharged to atmosphere.

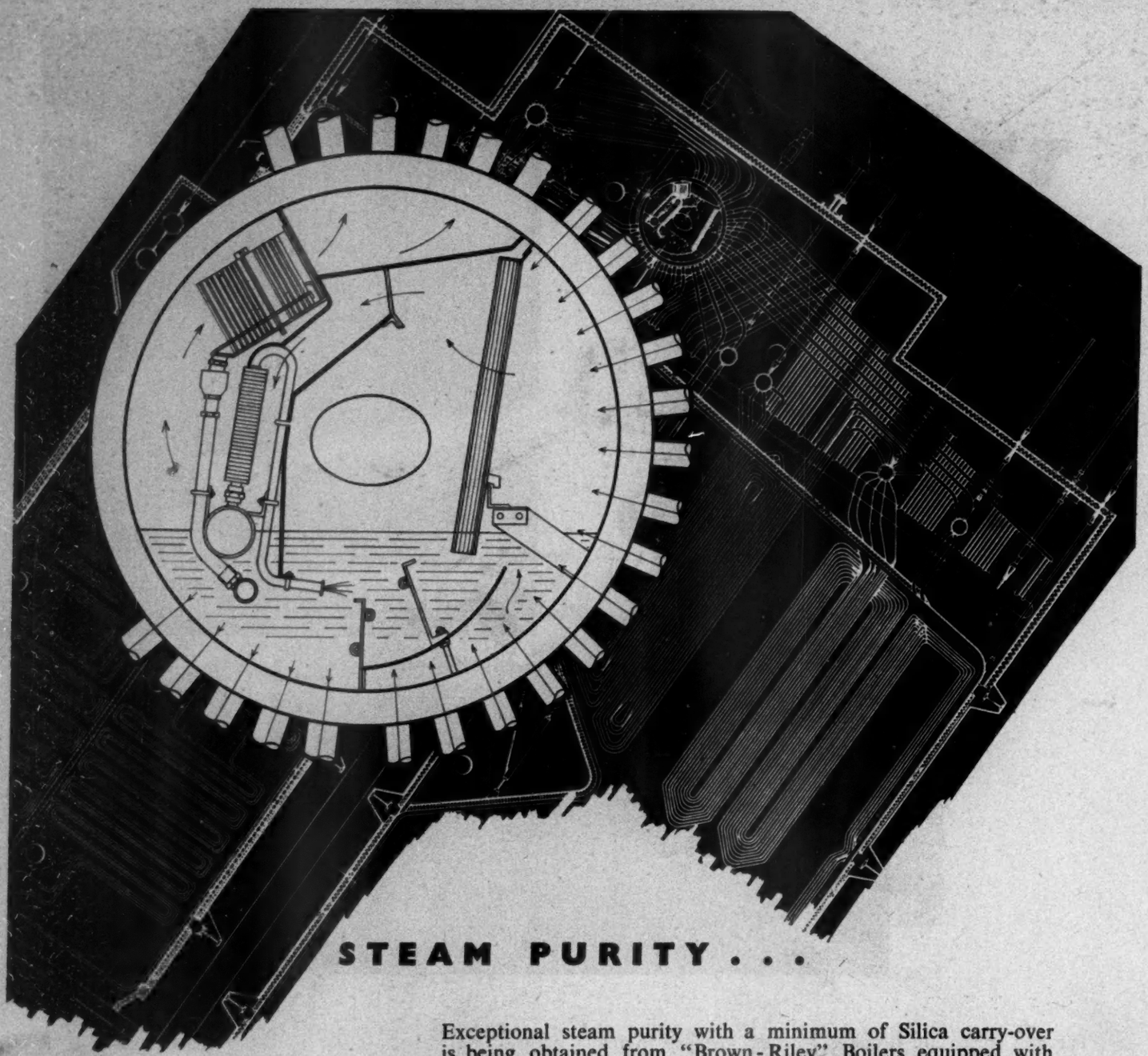
The collecting apparatus consists of six "Visco-Beth" Automatic Dust Collectors having a total of 120 compartments, and a total capacity of 110,000 c.f.m.

Experience shows that solids recovered from the fume by the equipment amount to approximately 0·5 per cent. of the furnace output.

We invite enquiries on all matters relating to Fume Removal and Dust Recovery.
If desired, our technical representative will be glad to call upon you.

THE VISCO ENGINEERING CO. LTD. STAFFORD ROAD, CROYDON

Phone: **CROYDON 4181**



STEAM PURITY . . .

Exceptional steam purity with a minimum of Silica carry-over is being obtained from "Brown-Riley" Boilers equipped with our Condenser Type Steam Purifying System.

Steam purity well below 0.5 p.p.m. is consistently obtained.

With "Brown-Riley" Units the arrangement of baffles and primary separators ensures that the steam is liberated above the working water level, and effects definite and rapid separation of steam and water. Feed water passes through the Condenser Purifier so that the temperature of the Purifier Elements is lower than the steam temperature. A certain percentage of the steam is consequently condensed as it passes over the Purifier Fins and consequently impurities are washed away by the condensate. "Brown-Riley" Purifiers are ruggedly constructed and the design of the system permits easy installation and removal.
Full particulars of these steam purifiers are available in our new Brochure No. P53/24.

JOHN BROWN LAND BOILERS LTD

WHITECROOK — 8, THE SANCTUARY, CLYDEBANK — London Office: WESTMINSTER, GLASGOW — LONDON, S.W.1

GENERAL FABRICATION

WELDING

PROFILE CUTTING

consult

ROBERTSON & FERGUSON LTD.

29, MURIESTON CRESCENT, EDINBURGH, 11 Telephone :— 46501 - 2 - 3

Front view of a fabricated steel frame for a special purpose 250 ton Knuckle Press.

Photograph by courtesy of Glacier Metal Co. Ltd.

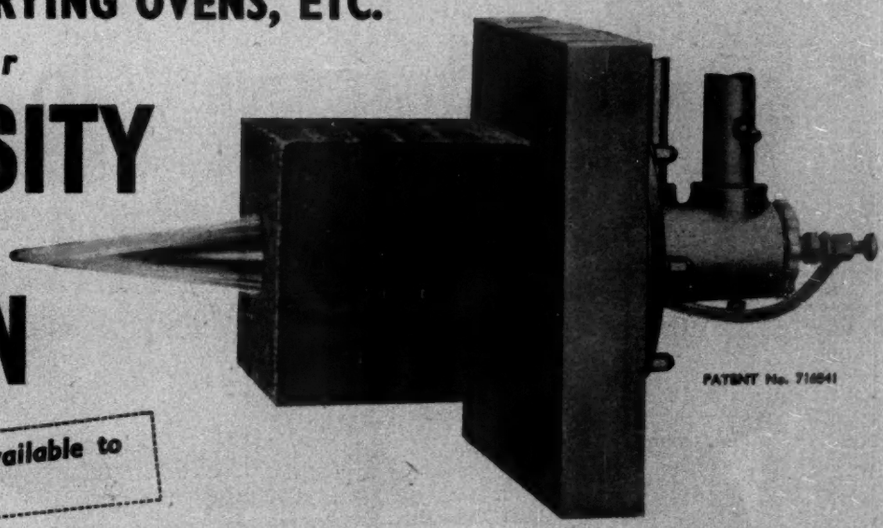
FURNACE ETCHELLS ENGINEERS

Designers and Manufacturers of

FORGE, GALVANIZING AND HEAT TREATMENT FURNACES, DRYING OVENS, ETC.

incorporating our

HIGH INTENSITY SMOKELESS COMBUSTION



PATENT No. 716841

Our Technical Staff are available to advise on all applications

DAVID ETCHELLS & SON LTD

FURNACE DIVISION

BULL PIECE WORKS, DARLASTON, SOUTH STAFFS

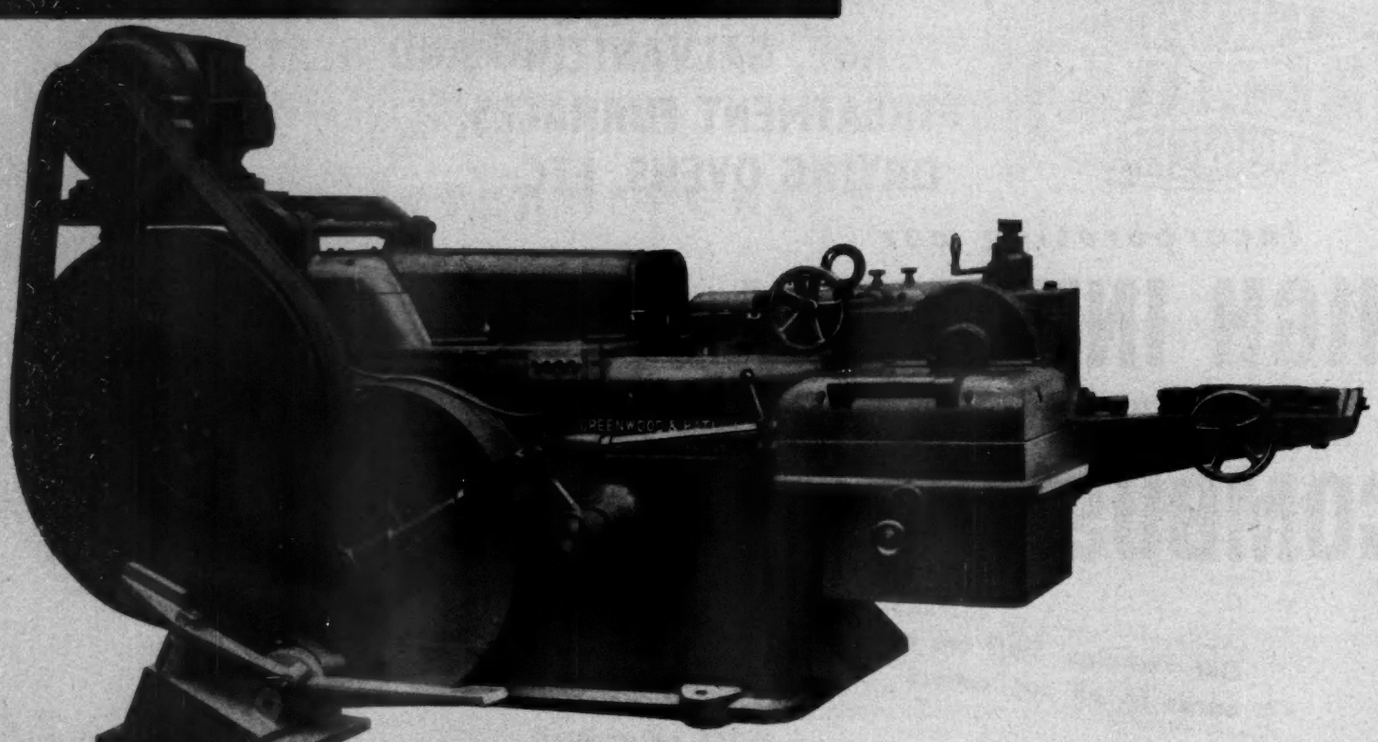
Phone: James Bridge 2067/8

SOLID DIE, SINGLE & DOUBLE BLOW

The machine illustrated is a Greenbat HIGH SPEED Cold Forging Machine, giving rapid production of accurate cold forged components comparable with machined components but at much less cost in material and production time. This high speed range of machines is available in sizes $\frac{1}{8}$" to $\frac{1}{2}$".
Also available is the standard range of Cold Forging Machines, handling sizes from $\frac{1}{8}$" to $\frac{1}{2}$".

high speed cold forging

GREENBAT *machines*

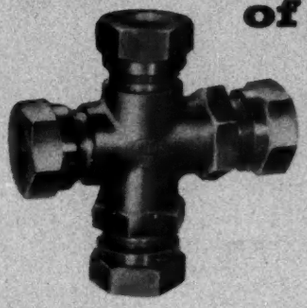


GREENWOOD & BATLEY LTD. ALBION WORKS, LEEDS 12

T.4

The international pipe couplings of proved efficiency

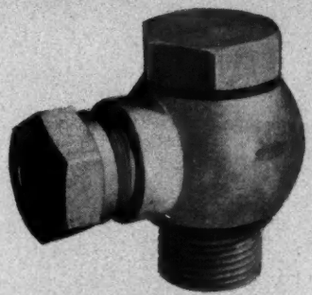
EQUAL ELBOWS to suit N.B pipe sizes ¼" to 1½" and O.D pipe sizes ½" to 2"



EQUAL CROSSES to suit O.D pipe sizes ½" to 2" and N.B pipe sizes ¼" to 1½"

ERMETO high pressure couplings have several outstanding qualities, not the least of which is their trouble-free service even in conditions of extreme vibration. Beyond the removal of burrs no work is necessary on the pipe ends. Joints are made in a matter of moments and when required can be broken and re-made any number of times without impairing the pressure tightness.

Because of our specialized knowledge we have created a range of fittings to suit almost every conceivable purpose, but we are always prepared to supply fittings to suit individual requirements.



BANJO COUPLINGS to suit O.D pipe sizes ½" to 2" and N.B pipe sizes ¼" to 1½"

STRAIGHT COUPLINGS to suit N.B pipe sizes ¼" to 1½" and O.D pipe sizes ½" to 2"

ERMETO

REGD TRADE MARK

Literature and catalogues gladly sent on request.

BRITISH ERMETO CORPORATION LTD
Hargrave Road · Maidenhead · Berks
Tel: Maidenhead 5100 (10 lines) Telegrams: Gramboe, Maidenhead

SEH SUNDWIG

20 Roll Reversing Mill for thin strip down to ·005 mm.

W 884b

SUNDWIGER EISENHÜTTE MASCHINENFABRIK GRAH & CO. HEMER-SUNDWIG i. WESTF.

Rubber mill drive for GOODYEAR

This 400 h.p. slipring induction motor, driving two rubber mills at the Wolverhampton Works Extension of the Goodyear Tyre and Rubber Company (Great Britain) Ltd., is capable of rapid emergency stopping. The inherent low rotor inertia of this 'ENGLISH ELECTRIC' slipring motor combined with the quick-acting stator-reversing contactors, ensures stopping times which are well within the recommendations of the National Joint Industrial Council Report—1952.

'ENGLISH ELECTRIC'

drives for the rubber industry

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

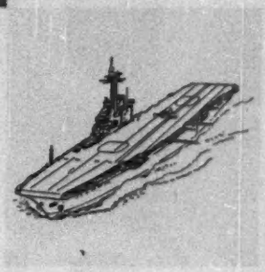
Electrical Plant Sales, Stafford

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

EE.33

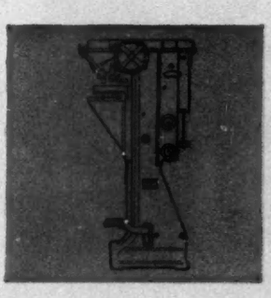
ENGINEERING WITH A BACKGROUND

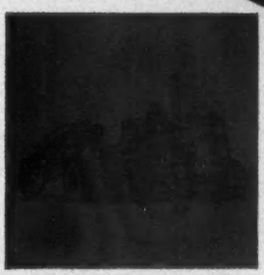
Marine Deck Machinery



Well-known for their compactness, efficiency and flexibility in use, Vickers-Armstrongs' self-contained electro-hydraulic cargo winches owe their success to a background of engineering achievement. History-making aircraft like the Viscount and Vanguard . . . fast ocean liners such as the new Canadian Pacific 'Empress of England' and giant tankers like the 'Spyros Niarchos' . . . these are headline news. Yet, in their own fields, hundreds of lesser-known products of Vickers-Armstrongs are equally important. Whether complex or simple, each shares the same background of outstanding design and sound constructional practice; each solves critical engineering problems.

The Vickers-Armstrongs self-contained cargo winch has been designed to meet the needs of rapid cargo handling. It combines the advantages of hydraulic transmission—flexibility, simplicity of control and high accelerating torque—with the ease of installation of an all-electric winch. 'VSG' automatic pressure control provides automatic overload protection. These dependable winches are suitable for operation under all climatic conditions, on either A.C. or D.C. supply.

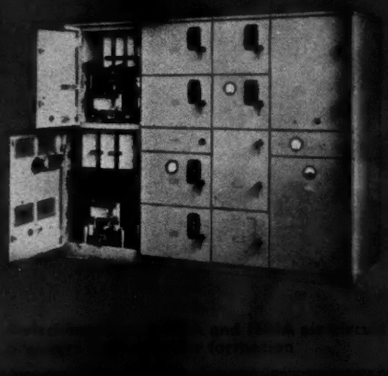




VICKERS

VICKERS-ARMSTRONGS (ENGINEERS) LTD
VICKERS-ARMSTRONGS (SHIPBUILDERS) LTD
VICKERS-ARMSTRONGS (AIRCRAFT) LTD
VICKERS-ARMSTRONGS (TRACTORS) LTD
Vickers House Broadway London SW1

B



on guard

... night and day, year in, year out —always ready for action. G.E.C. Switchgear has been proved by the most stringent tests at the works. But that's not all. This inherent reliability has been proved, time and again, at hundreds of installations all over the world.

There is Switchgear for every purpose in the G.E.C. range of equipment.

RING MAIN SWITCHGEAR
3.3kV to 11kV—up to 250 MVA at 11kV. With fault-making oil switches in extensible or non-extensible form.

INDOOR AIRBREAK SWITCHGEAR
30 MVA at 400/660V and up to 250 MVA at 3.3kV.

METALCLAD SWITCHGEAR
3.3kV to 33kV—up to 1500 MVA at 33kV. Units up to 250 MVA at 11kV available from stock.

OUTDOOR OIL CIRCUIT BREAKERS
11kV to 132kV—up to 5000 MVA at 132kV. Breakers up to 750 MVA at 33kV available from stock.

You are invited to ask for the Technical Descriptions of the above switchgear

G.E.C. power control equipment

THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND

HEAD OFFICE: MAGNET HOUSE KINGSWAY LONDON WC2

Over 100 years service to Britain's Engineering Progress

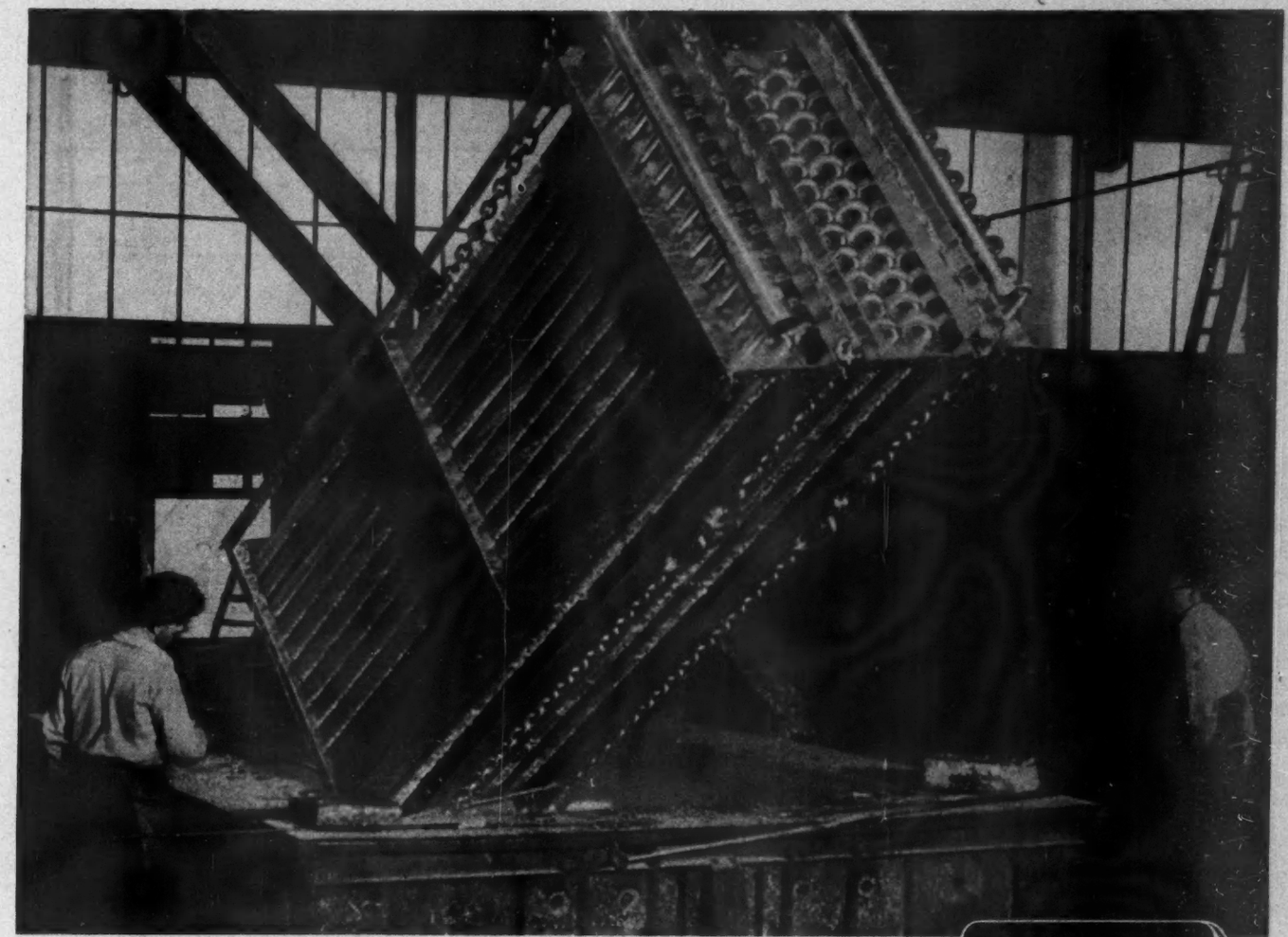
A Company's reputation is built up on the quality of the work which it produces. During the past 100 years the name of The Darlington Forge Limited has grown to be associated throughout the world with the production of Forgings and Castings of the highest order for the Marine and General Engineering Industries.

In the past, the Company's moulding pits and forging presses have produced structural and engine components for many of the world's greatest ships. Today they are making their own invaluable contribution to the expansion of Britain's heavy industrial capacity.

DF

The Darlington Forge Ltd

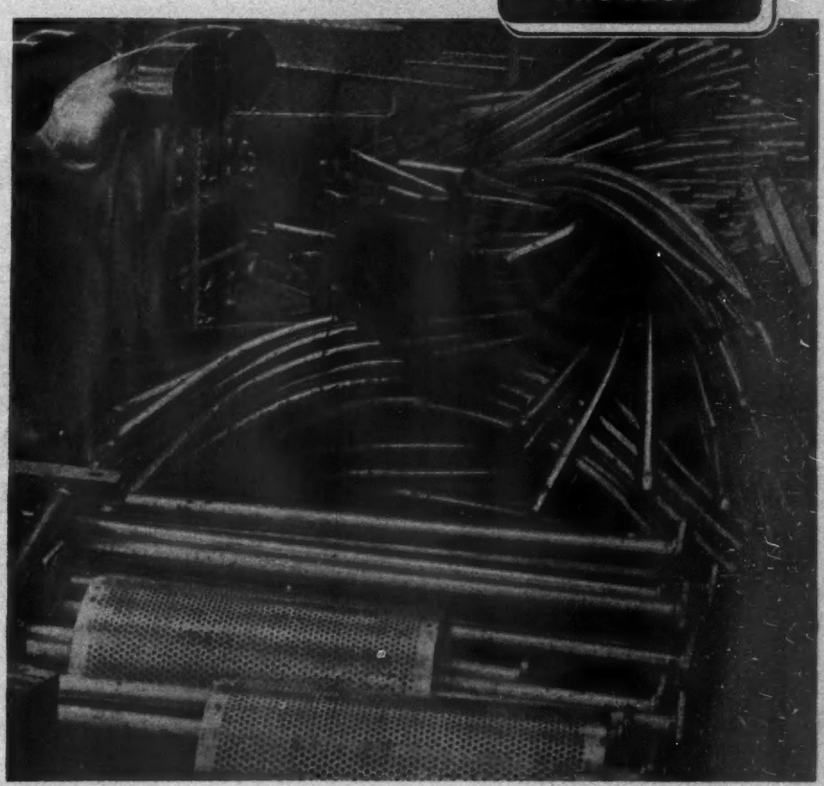
DARLINGTON



HOT-DIP GALVANIZING

BY THE 'HARCO' PROCESS

An efficient service to Industry



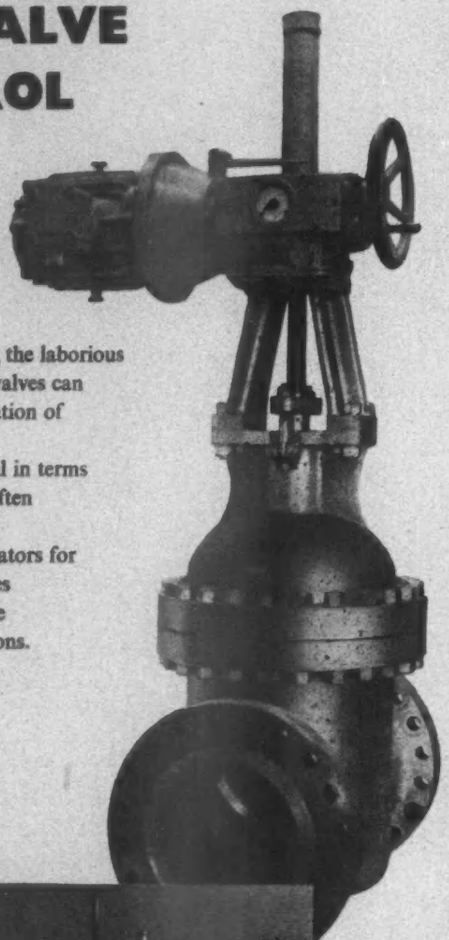
As pioneers of hot-dip galvanizing Harveys have exceptional facilities for its application, including baths 15 ft. x 7 ft. x 5 ft. 9 in. deep and 30 ft. x 3 ft. x 5 ft. 6 in. deep.
Regular and frequent collections and deliveries by Harvey Vans within a radius of 25 miles. Rail Traffic handled through private sidings.

Harvey

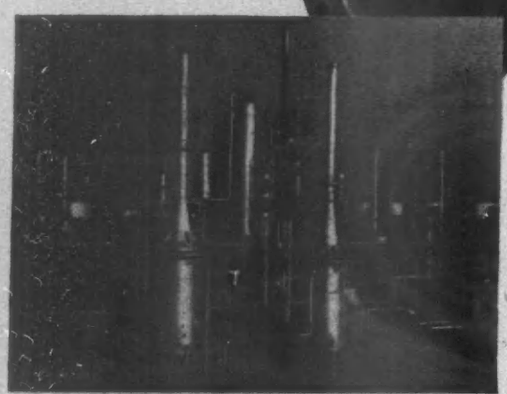
G. A. HARVEY & CO. (LONDON) LTD.
WOOLWICH ROAD, LONDON, S.E.7
Telephone: GREenwich 3232 (22 lines)

C

ROTORK ACTUATORS FOR VALVE CONTROL



In this age of automation, the laborious hand-control of pipeline valves can hamper the efficient operation of associated plant.
Manual control is wasteful in terms of time and labour, and often unnecessarily hazardous.
Rotork make electric actuators for operating all sizes and types of valve from local, remote or automatic control stations.



In the Powerformer Unit at the Esso Refinery at Fawley, Rotork-motorised wedge-gate valves of 2in. to 16in. size, classes 150 to 600 are used, a number of which are controlling hydrogen at 565 p.s.i. and 1,000 deg. F.
The Crane valve in this illustration is fitted with a Rotork 100A Actuator, Buxton Certified FLP Groups II and III.

MAY WE SEND YOU OUR BOOKLET ABOUT VALVE MOTORISATION?

Rotork do not manufacture valves. All enquiries for complete motorized valves are referred to the appropriate valve manufacturers, with whom we work in close collaboration, accompanied by our recommendations for the type of actuator most suitable for the particular application.

ROTORK ENGINEERING COMPANY LIMITED
BATH, SOMERSET Tel. 64558

inside or outside . . .

UNIVERSAL
Conveyors

Free illustrated Catalogues are available on request

UNIVERSAL CONVEYOR CO. LTD · BARKBY ROAD · LEICESTER
Phone: Leicester 67822/3

We're losing our grip SAID THE NUT TO THE BOLT

Forget about vibration and slackness—fit a Kolok Positive Lock Washer between each nut and bolt.

We need a **KOLOK** *Positive Lock Washer*

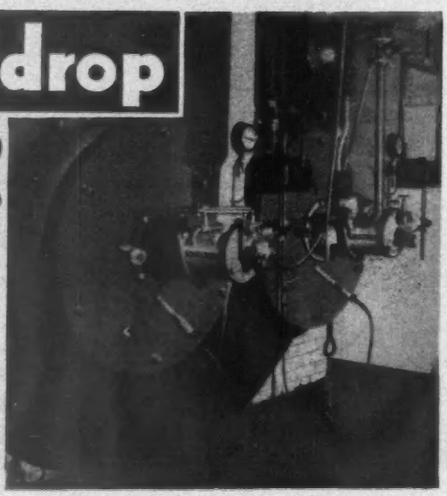
POSITIVE LOCK WASHER CO. LTD., 45 RENFREW STREET, GLASGOW
Telephone: DOUglas 9292

Schieldrop

OIL FIRED BOILERS

We Guarantee

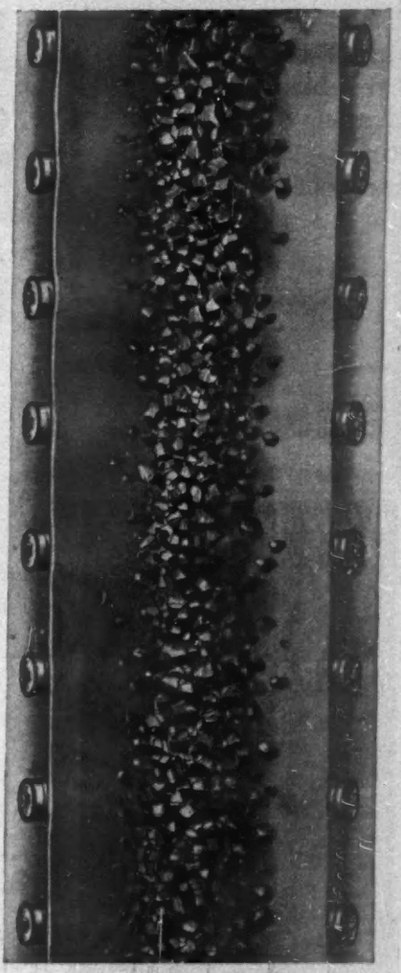
13½ to 14 per cent CO_2 with Shell Smoke number 4 or less.



Schieldrop & CO. LTD
STOTFOLD, BEDS. Tel. 414 (3 lines)
BMJ

CONVEYOR PROBLEMS?

Then get Goodyear, the world's most economical, most widely used belts



Whatever materials you convey there is a Goodyear Conveyor Belt that is made to do the job—at the lowest cost per ton.

The features opposite are those essential for dependable, long life belt service—the features you get when you buy Goodyear.

Remember that Goodyear technicians are always available to ensure that you get the right belt for the job and will advise on installation and maintenance.

Write now for further information to the Goodyear Tyre & Rubber Company (G.B.) Ltd., Industrial Rubber Division, Wolverhampton.

1 PROPER TROUGHING

To ensure correct idler contact.

2 MILDEW-INHIBITED

Construction prevents mildew rot that can ruin belts.

3 LONGEST COVER LIFE

Comes from use of tough highest quality covers that ensure maximum resistance to abrasion and stripping.

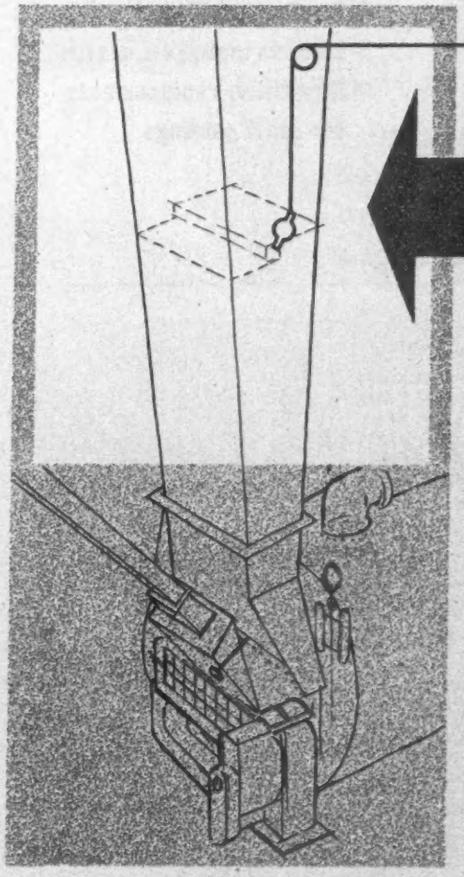
4 HIGH FLEX-LIFE

Greater flex-life because of skim coating between plies with highest quality friction rubber.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS

CONVEYOR BELTING · TRANSMISSION BELTING · V-BELTS · FENDERS · HOSE



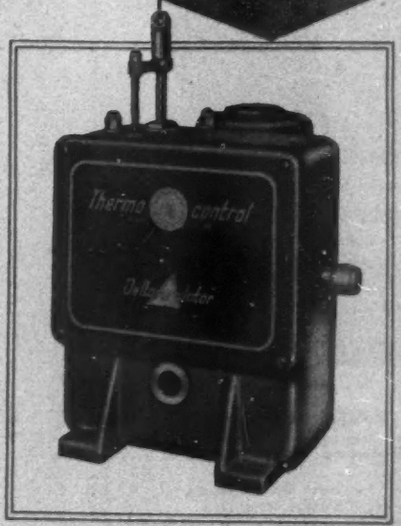
CONTROL FLUE DRAUGHT WITH THE DELTA REGULATOR

Draught constant within ±0.01" w.g.

Accurate control of flue draught or combustion chamber pressure is a vital factor in combustion efficiency. The Delta Regulator is designed to maintain constant conditions to within ±0.01in. w.g. and, once adjusted, is entirely automatic. Hundreds of these instruments have been operating for many years entirely without attention on installations employing automatic gas or oil firing, mechanical stoking or manual stoking. They have paid for themselves in fuel savings often within a few months.

The Delta Regulator is simple in operation. An extremely sensitive draught or differential pressure sensing device transmits a signal to an air relay which in turn operates a hydraulic ram capable of an 800 lb. thrust which is available to position the flue damper with precision. No service other than an electricity supply is necessary.

Thermocontrol are experts in all matters concerning the application of automatic control to steam generation, industrial processes, heating and ventilating, and our application engineers are at your service. Ask us to send you further details of the Delta Regulator, or to arrange for an engineer to call.



Thermo control INST. CO. LTD.

THERMOCONTROL INST. CO. LTD. 10, VALENTINE PLACE, S.E.1. Tel: WAT 7356

Railway Switches and Crossings Turntables · Water Cranes · Tanks Pipes · Bridges and Roofs

★

ISCA FOUNDRY COMPANY · LIMITED

Phone:— NEWPORT · Mon.

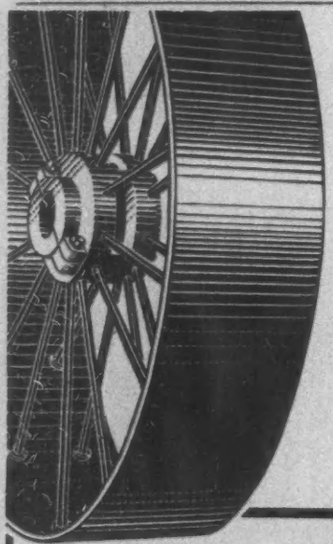
Newport, Mon. 5224/5
London, Abbey 6407/8

London Offices:
38 Victoria Street, S.W.1

LUBRICATING PROBLEMS CAN BE SOLVED WITH THE NEW

ASSEMBLY
GRAPHOGEN
COMPOUND
M AND G

STAMCO MANUFACTURING CO. LTD.
8 WOOD STREET, KINGSTON-ON-THAMES



ALL SIZES - BUT ONLY ONE QUALITY - THE BEST!

PULLEYS

BY

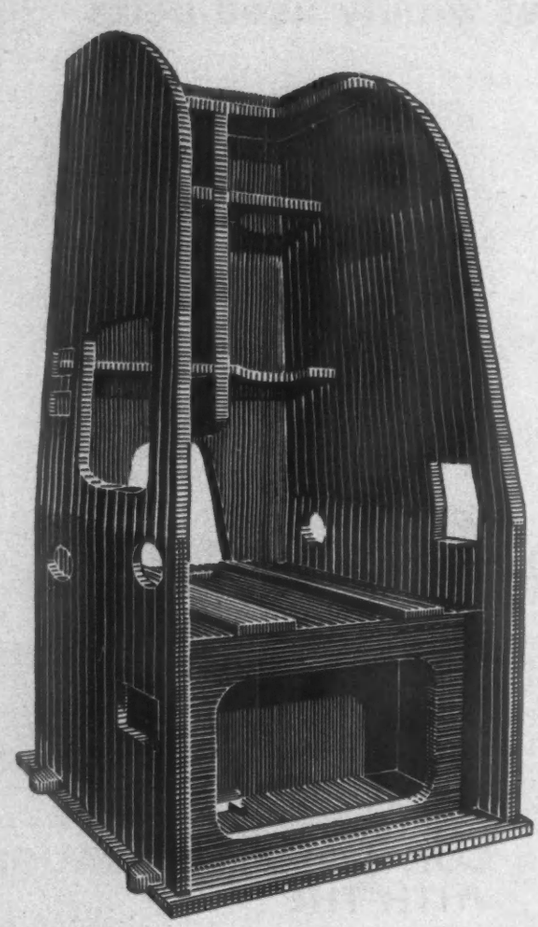
DOUGLAS, LAWSON AND CO. LTD.

BIRSTALL · LEEDS · ENGLAND

Telephone: Batley 598 & 599
Telegrams: "Pulleys" Birstall, Leeds

• DOUGLAS, LAWSON PULLEYS
• "STANCHION" PULLEYS
• DESTRON SPLIT PULLEYS • STEEL ROAD WHEELS

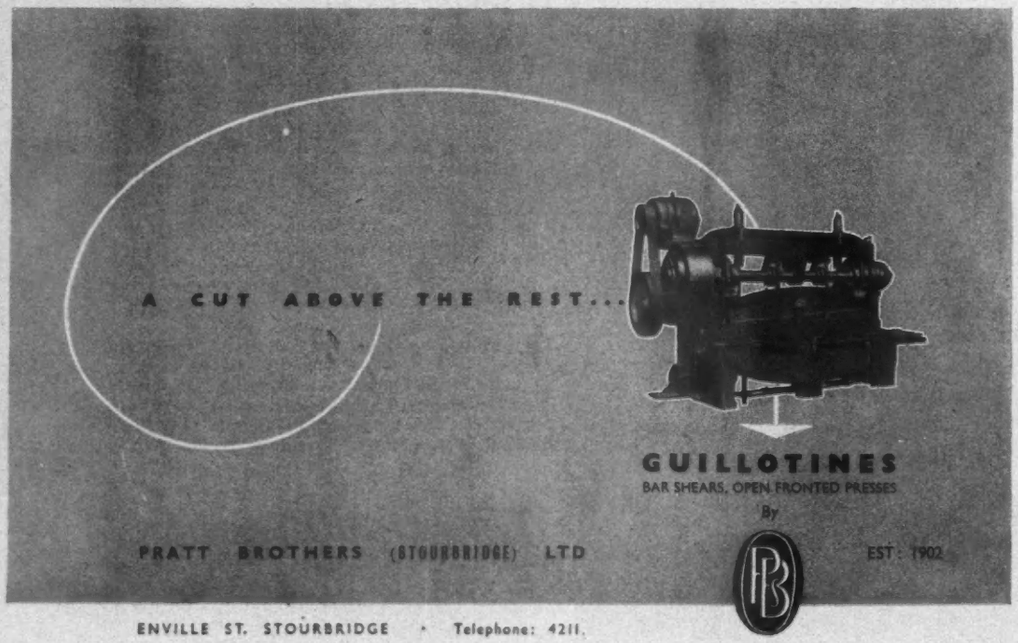
Your Specification . . .
SHEEPBRIDGE Fabrication . . .
Satisfaction!



Fabrications of all types in medium and heavy steel plates . . . fabrications to your own drawings and specification. Whatever your needs you'll find that Sheepbridge can handle the job. Here are the full machine shop facilities you may need . . . Here are the latest skilled burning and welding techniques . . . And here are the efficient service and attention to detail that will ensure a good fabrication to *your* satisfaction. Next time, see Sheepbridge to make sure you get the best.

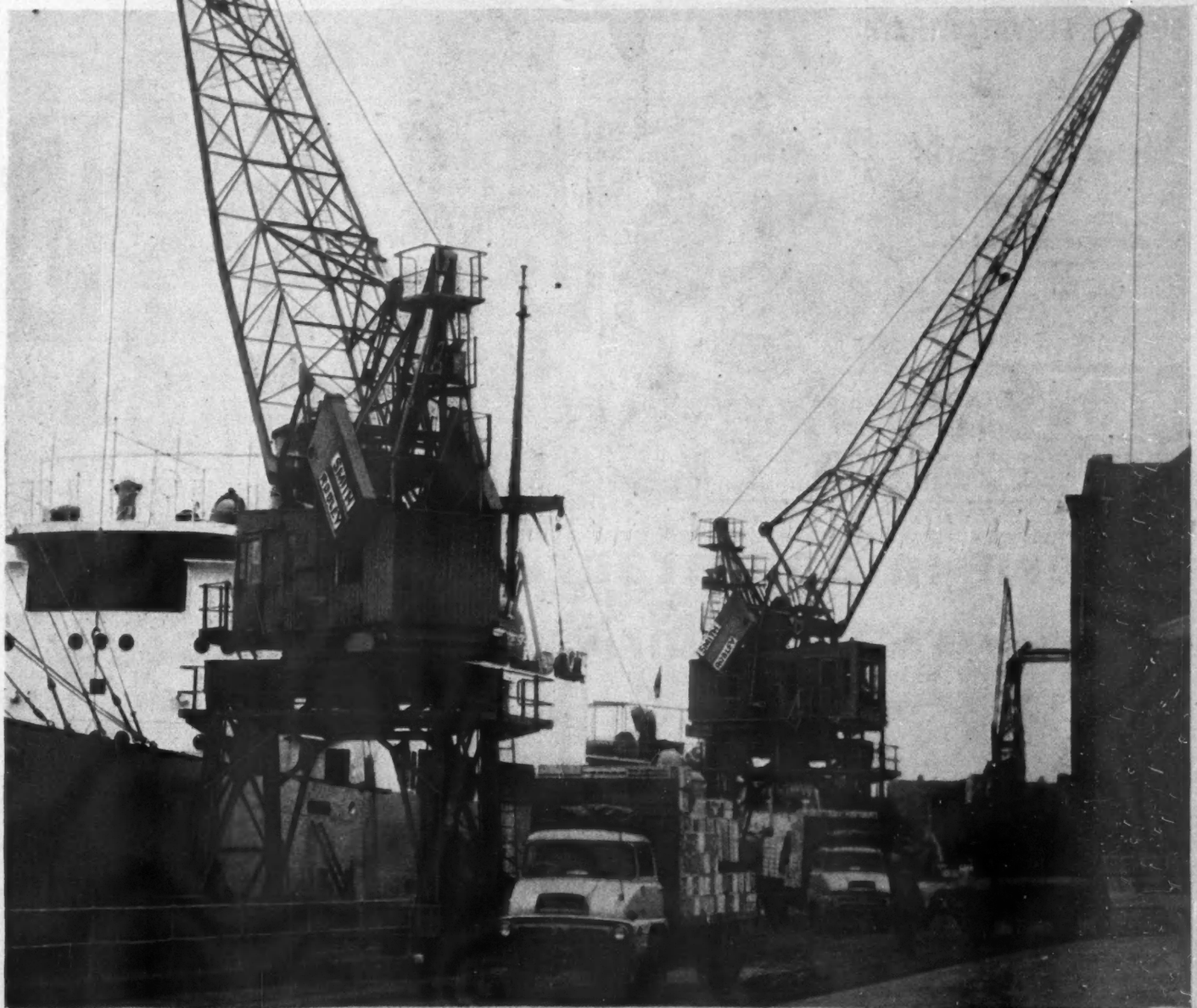
- **Machine tool frames**
- **Welded vessels**
- **Electric motor carcasses**
- **Repetition replacements for steel castings**

Sheepbridge Equipment Limited • Chesterfield • England
One of the Sheepbridge Engineering Group
Telephone: Chesterfield 5471 Telegrams: Sheepbridge Chesterfield



SPEED-UP CARGO-HANDLING!

with **Smith** LEVEL-LUFFERS



Smith LEVEL-LUFFING DOCKSIDE CRANES

Smith Electric Level-Luffing Portal Cranes save many hours of valuable time in loading and unloading cargo. The Smith Level-Luffer, with its high working speeds and low current consumption does the job with unsurpassed efficiency.

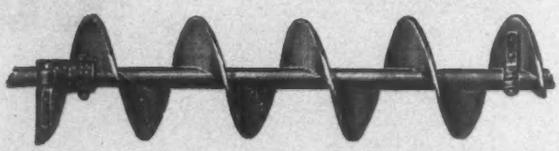
★ *Picture shows two Smith Level-Luffers, with a lifting capacity of 3 tons at 55ft. radius, on duty at Dover Harbour.*

THOMAS SMITH & SONS (RODLEY) LTD. · RODLEY · LEEDS · ENGLAND

CONVEYOR AND ELEVATOR Co (1936) LTD.

LOWER BRIDGE WORKS

SPIRAL CONVEYORS,
BUCKET ELEVATORS, Etc.



ACCRINGTON

Telephone: No. 2779
Telegrams: "Conveyor," Accrington

New threads for old..

in damaged components

Hard tough threads in soft materials, used and approved by the Aircraft industry designed for use in soft metal components wood or plastics. Simple to use, remains permanently in place. Full range of standard sizes in B.S.W.: B.S.F.: B.S.P.: B.A., U.N.F.: U.N.C. and Metric thread forms.

Cross WIRE THREAD INSERTS

CROSS MANUFACTURING CO. (1938) LTD.
Tel: Combe Down 2355-8 BATH, SOMERSET Grams: Circle, Bath.
Specialists in JET ENGINE LABYRINTHS, CIRCLIPS, SPRING WASHERS, SPRINGS etc.

CASTINGS

HIGH QUALITY ENGINEERING & MACHINE TOOL CASTINGS

HEAT & WEAR RESISTING UP TO 10 TONS also in SPHEROIDAL GRAPHITE IRON & STEEL

MACHINING

R. GOODWIN & SONS (ENGINEERS) LTD.
IVY HOUSE FOUNDRY, HANLEY, STOKE-ON-TRENT Phone: Stoke-on-Trent 23612

Modern in appearance-
Unrivalled for Efficiency—

The Arclight Combined Drafting Reference Unit, in Steel

This strikingly designed drafting-reference table, with its neat 'contemporary' lines and fully-adjustable board, is soundly constructed throughout and has faultless finish. It is produced in two sizes—Double Elephant and Antiquarian, and provides "back reference" facilities for use in planned multiple layouts. Four drawers (one fitted with Yale lock) and a pull-out tray are all accessible from the reference side of the unit. A bookshelf is fitted for use on the drafting side. The table is made from high-grade furniture steel and finished in hammer tone grey stoved enamel.

Drawing Office Investigation.

A special consultative service for Planned Drawing Office layout is provided by Masons of Colchester. From a minimum of basic details—overall dimensions of the office, position of fixtures and number of personnel to be accommodated—initial layout suggestions are provided and finally, large-size, coloured perspective drawings are prepared.

Firms contemplating the planning of new drawing offices or the re-designing of existing premises, are invited to avail themselves of this service, which is entirely free.

E. N. MASON & SONS LTD

ARCLIGHT WORKS, COLCHESTER	Tel.: Colchester 5191-8	ALBERT ROAD, STECHFORD, BIRMINGHAM, 33	Tel.: Stechford 3580
291-293 HIGH HOLBORN, LONDON, W.C.1	Tel.: CHAncery 6411-4	51 VICTORIA STREET, SHEFFIELD, 1	Tel.: Sheffield 21776
13-15 ST. VINCENT PLACE, GLASGOW, C.1	Tel.: Central 3775-6	3 UNITY STREET, BRISTOL, 1	Tel.: Bristol 92441
8-10 NEWTON STREET, MANCHESTER, 1	Tel.: Central 9221-2	6 BRITANNIA HOUSE, WELLINGTON ST., LEEDS, 1	Tel.: Leeds 23537

who's picking your pocket?

SPILLAGE in milk and chemical food processing can be just as big a "pick pocket" as other items which push up overheads and eat into hard-won profits.

Creeping insidiously between tiles or paviours, crumbling the jointing and attacking the sub-floor beneath, it soon causes defective floors. This can be dangerous. It is unhygienic. It will also cost a good deal in repairs or re-flooring, besides holding up processing while these are effected.

Proof your factory floors against corrosion. SEMTEX specialise in anti-corrosion treatments of all types and have the experience and resources to handle every problem of this kind. They can save you money! Consult

Semtex

INDUSTRIAL DIVISION

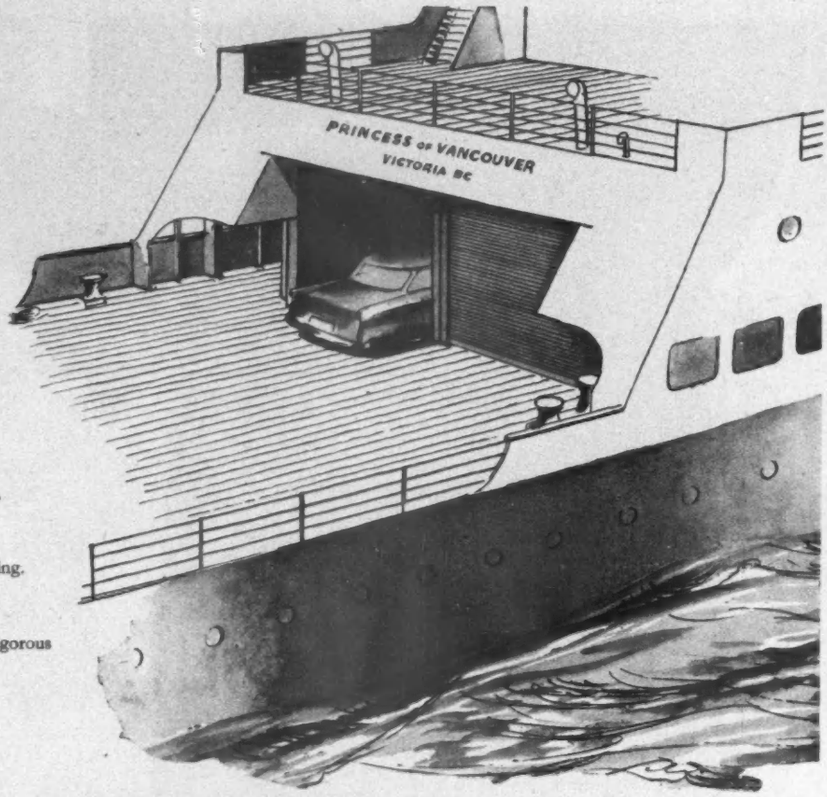
Specialists in anti-corrosion treatments and industrial flooring

This free book will give you full details of the SEMTEX Anti-corrosion Service — write for it today!

SEMTEX LIMITED, INDUSTRIAL DIVISION, DEPT. E7, 50 BLACKFRIARS ROAD, SALFORD 3, LANCASHIRE. *TEL: DEANSGATE 2128*

CESS OF VANCOUV
BRADY

goes to sea



The last car rolls aboard . . . . . down come the huge shutters, and another trip begins for the "Princess of Vancouver." Brady Steel Rolling Doors are suitable for any size or kind of opening. They are designed for strength and trouble-free operation which guarantee a hundred per cent performance even in the most rigorous conditions and justify absolute confidence in their security. Hand or power operated, they are available singly or in series. Send for illustrated leaflet S35.

G. Brady & Company Limited, Manchester 4. Telephone COLlyhurst 2797/8/9.
BRADY FOR EVERY OPENING: BRADY ROLLING DOORS IN STEEL, WOOD AND ALUMINIUM . SLIDING SHUTTER DOORS . GRILLES IN STEEL, ALUMINIUM OR NYLON . UP AND OVER DOORS . FIREPROOF DOORS . COLLAPSIBLE GATES . SLIDING DOOR GEAR

BRADY SHUTTERS · ROLLING DOORS

LONDON, BIRMINGHAM, GLASGOW
MONTREAL, PORT CREDIT, HONG KONG.

THE DOORS COMMANDING THE WORLD'S LARGEST SALE—

4021
Drop-bottom swarf bin capacity 5 cwt.–40 cwt.

PALLETS EIGHT

OR EIGHTEEN - OR EIGHTY

We are producing new designs nearly every day—many of them designed to meet customers' special needs. Here are eight of the latest, one of which may be just what you are looking for. Companies representing nearly seventy different industries have found the answer to their mechanical handling or storage problems in M.G.K. Pallets. The same service is available to you—M.G.K. have the answer to YOUR Palletisation problems.

937
Reversible flat/post pallet, two-way entry, tubular posts.

M.G.K. ENGINEERING COMPANY LTD.

Regd. Offices
GAZETTE BUILDINGS, CORPORATION STREET BIRMINGHAM, 4
Telephone: CENtral 2517
Telegrams: KATELBEE BIRMINGHAM

New Works
KINGSBURY ROAD, CURDWORTH, SUTTON COLDFIELD, WARWICKSHIRE,
Telephone: CURdworth 60/61

920
Post-type pallet with removable slatted sides.

827
Heavy duty timber/steel two-way entry pallet.

862
Trolley to mobilise pallets, tug-lift attachment or castors.

1074
Two-way entry racks for work pans. Sizes to customers' needs.

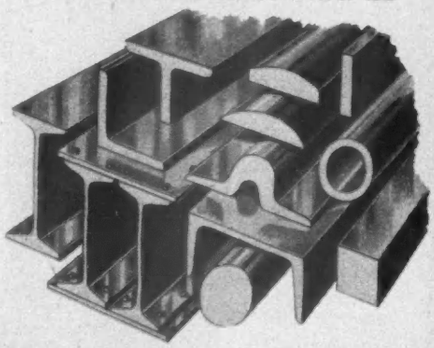
568
Rotary tilt bin with flat base.

646
Collapsible wire mesh crates.

STEEL

SHEETS
PLATES
AND
SECTIONS
•
BRIDGE
RAILS
•
IRON &
STEEL
MERCHANT
BARS
•
HOOP
•
STRIP
•
CHEQUERED
PLATES

SHEARED · COLD SAWN & PROFILE CUT TO ALL THICKNESSES & SHAPES



HALL BROS

WEST BROMWICH LTD

EAGLE WORKS · GREETS GREEN
WEST BROMWICH
Telephone: TIPTON 1611 *(10 lines)*

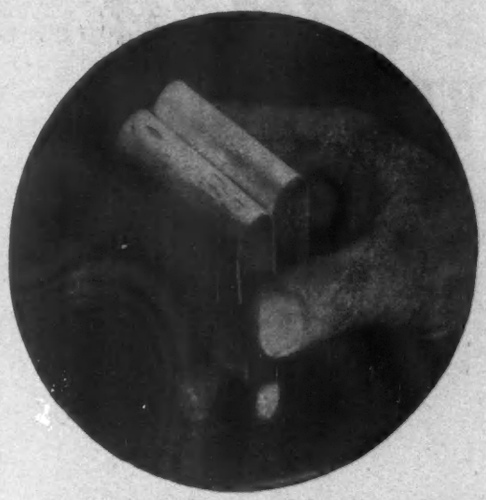
Can you use it?

Here is a conveyor-fed Niagara Vibratory Screen equipped with water sprays. It is producing two sizes of clean gravel to close specification. The sand is reclaimed by a belt and bucket type dewaterer. This plant is earning money for its owner through the quality and rapidity of its output. Adapted to your own particular needs and conditions, it can do as much for you. Please do not hesitate to write us if the whole or any part of this plant is of interest to you. Our experts are ready to be constructive on its adaptation.

NIAGARA experts are ready to be constructive on any question of installation

NIAGARA SCREENS (Gt. Britain) **LTD.**
Straysfield Road, Clay Hill, Enfield, Middlesex.
Telephone: Enfield 6622 (4 lines)

Are these hands helping you?



The certain remedy for any paint failure lies in the capable hands of the technical experts who form the nucleus of our research division. Pinchin Johnson research laboratories provide a unique service to industry, devoting their attention solely to the creation of the best type of finish for every purpose. The P.J. technical representative is your direct contact with this unique service.

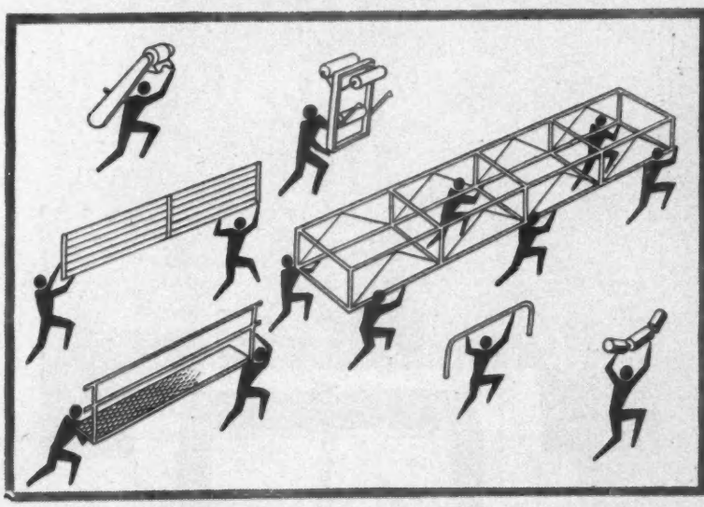
You can rely on

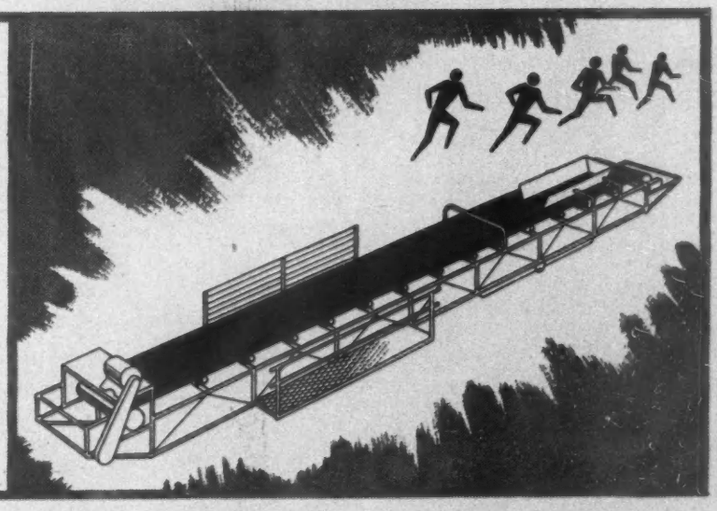
PINCHIN JOHNSON

for Paint and Service

PINCHIN, JOHNSON & CO., 4 CARLTON GARDENS, S.W.1
Telephone: TRAfalgar 5600
BELFAST · BIRMINGHAM · BOOTLE · BRIGHTON · BRISTOL · GLASGOW
LEEDS · MANCHESTER · NEWCASTLE-ON-TYNE · SOUTHAMPTON

It's as simple as this....and from stock





MAXIMum production —minimum outlay!

When considering your next Conveyor, think of the advantages to be gained by installing inexpensive, rugged, long life Maxim Conveyor Units.

- Costly designs, drawings and engineering time for building eliminated.
- Easy erection by your own labour. Each part being clearly marked on "Easy to read assembly drawings."
- All parts standardised and interchangeable, making for simplicity in lengthening, shortening or re-erecting Conveyor.
- Even when ordering small or medium size quantities, you get the advantage of large quantity production.

We will be pleased to send you full details.

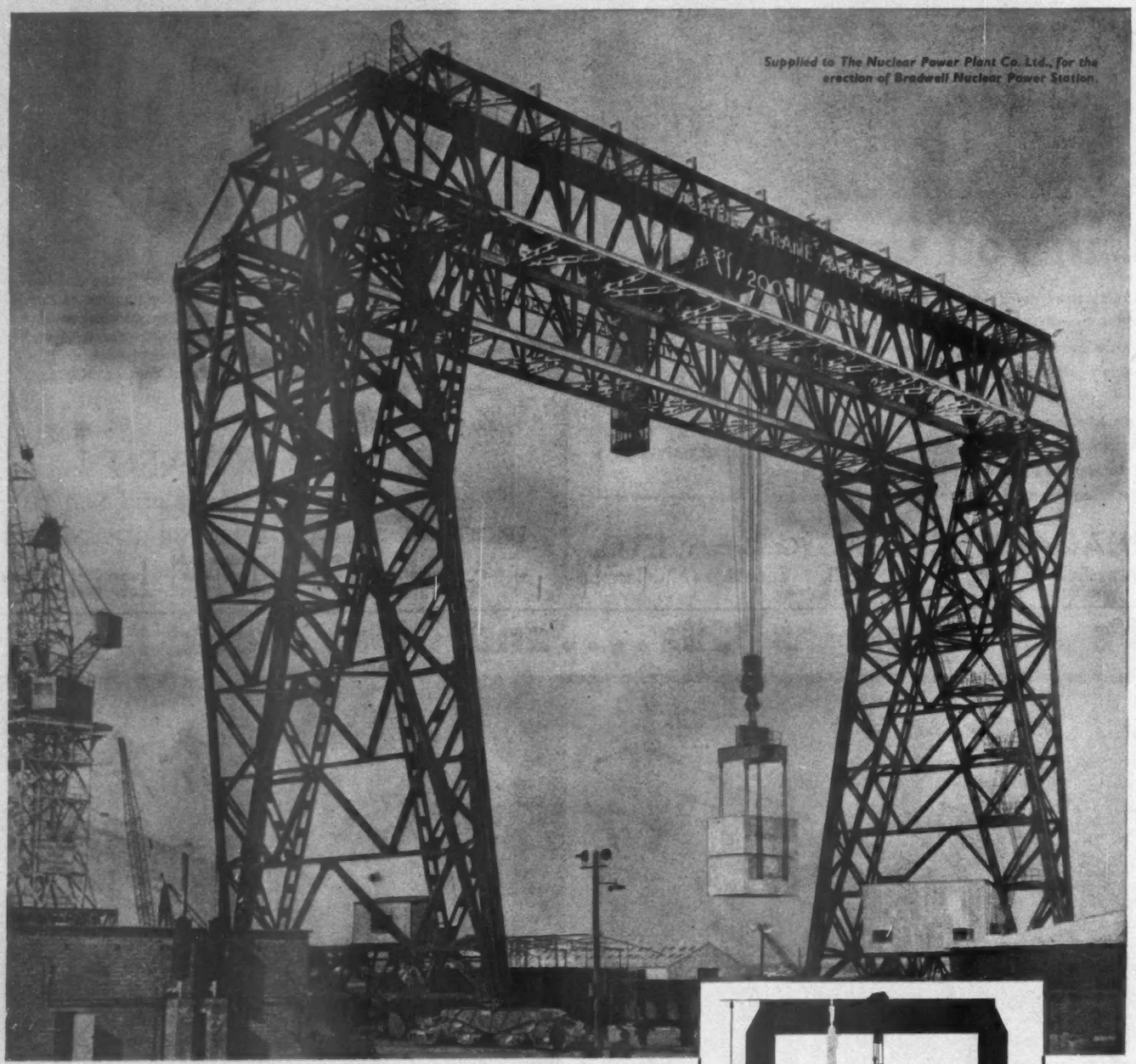
MAXIM

CONVEYORS (ENGLAND) LTD.

Crabtree Manorway, Belvedere, Kent. *Phone: ERITH 4223 & 5751.*

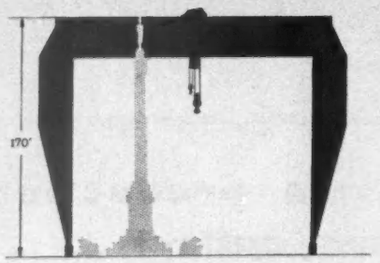
Britains biggest Crane ..

CLYDE-BOOTH 200 TONS GOLIATH



Supplied to The Nuclear Power Plant Co. Ltd., for the erection of Bradwell Nuclear Power Station.

Shown lifting concrete test blocks representing the maximum working load of 200 tons, this Goliath was built by Clyde Crane & Booth Ltd., for the erection of Bradwell Nuclear Power Station. Taking into account the lifting capacity and overall dimensions, it is believed to be the largest of its type in operation in this country and probably the world.



The Booth Goliath showing Nelsons Column on the same scale. Clearance from rail level to underside of bridge is 140'. Distance between rail centres 178'.

CLYDE BOOTH

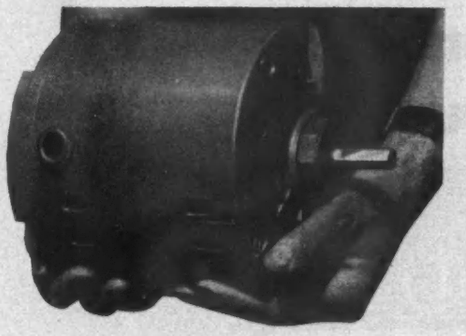
CLYDE CRANE & BOOTH LIMITED

Incorporating

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.
Phone: Holytown 412 (6 lines) Grams: 'Clyde' Motherwell

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds.
Phone: Pudsey 3168 (6 lines) Grams: 'Cranes' Rodley

MERLIN



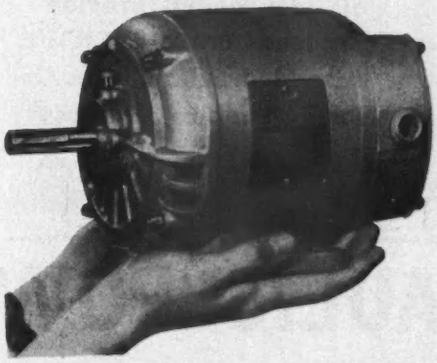
A modern motor for today's exacting and competitive markets. Made for single and three phase supply in a range of types with or without feet, flange or resilient mounting.

A washing machine type is available.

Size: Foot mounting ¼ h.p. 1420 r.p.m. H. 6 11/16 × L. 10½" × W. 6¾".

Washing Machine (no foot) Dia. 6 11/16 × L. 9½".

BROOK
FRACTIONAL HORSEPOWER
ELECTRIC MOTORS



GRYPHON

The best fractional you can buy. A competitive variety of types and enclosures ensures a motor for every need. Single or three phase supply. All motors backed by service throughout the world.

Size S.175. ¼ h.p. 1420 r.p.m. H. 6 11/16 × L. 10¾" × W. 6¾".

BROOK MOTORS LIMITED
HUDDERSFIELD

56/25

PETROL & OIL TAPS

Look after the small parts—that is the first principle of efficient manufacturing. Rotherham Petrol and Oil Taps and other precision small parts such as Grease Cups, Oil Indicators, etc., ensure by their faultless accuracy that there is no weak link in the chain of production. We manufacture standard parts of our own design or to your specifications.

Rotherhams OF COVENTRY

ROTHERHAM & SONS LTD.
COVENTRY. Tele.: 64154
PRECISION MANUFACTURERS SINCE 1750

RE

EXPERIMENTAL AND DEVELOPMENT WORK
PROTOTYPES

Design, Manufacture and Test Special Purpose Machines

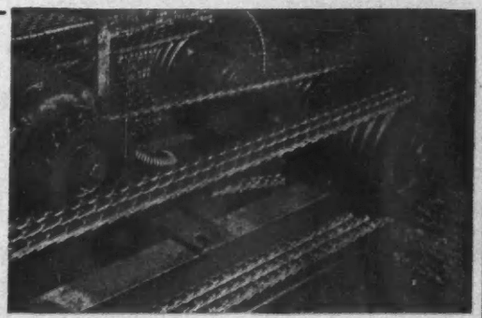
Precision Engineering from Small Scientific Instruments to Machines and Apparatus of Several Tons

Over 30 Years' Experience

RESEARCH ENGINEERS LTD.
NORTHAMPTON GROVE, CANONBURY, N.1
Tel: CAN 4244/5/6

RIVLINK
The SUPER BELT
for all VEE DRIVES

- Made in RUBBER FABRIC
- Least Stretch—Longest Life
- Each Link a Complete Unit
- Detachable and Adjustable



RIVLINK BELTS LTD.
NORTH STREET · OPENSHAW
MANCHESTER 11 Telephone: EASt 2302

HAMMERED OR HYDRAULIC PRESSED
FORGINGS
IN STEEL
BLACK OR MACHINED
TO 24 TONS

INCE FORGE CO. WIGAN
PARKS FORGE LTD
PROPRIETORS

* When 'near enough' is not good enough...

ACRATORK Regd.

PRECISION TORQUE SPANNERS

L3 TEST RIG

DESIGNED FOR THE HIGHEST STANDARD OF ACCURACY

Some leading users of "ACRATORK" equipment

Sir W. G. Armstrong Whitworth Aircraft Ltd.
British Overseas Airways Corporation · British European Airways Corporation
Bristol Aircraft Company Ltd. · The British Thomson-Houston Company Ltd.
The De Havilland Aircraft Company Ltd. · The English Electric Company Ltd.
Ferranti Ltd. · The General Electric Company Ltd. · Girling Ltd.
Hawker Aircraft Ltd. · Humber Ltd. · Imperial Chemical Industries Ltd.
Marconi's Wireless Telegraph Company Ltd. · Ministry of Supply,
National Coal Board · F. Perkins Ltd. · The Plessey Company Ltd.
Rolls Royce Ltd. · A. V. Roe & Company Ltd. · The Royal Air Force.
S. Smith & Sons (England) Ltd. · Standard Telephones & Cables Ltd.
United Kingdom Atomic Energy Authority · Vauxhall Motors Ltd.
Vickers-Armstrongs (Aircraft) Ltd.

World Distributors

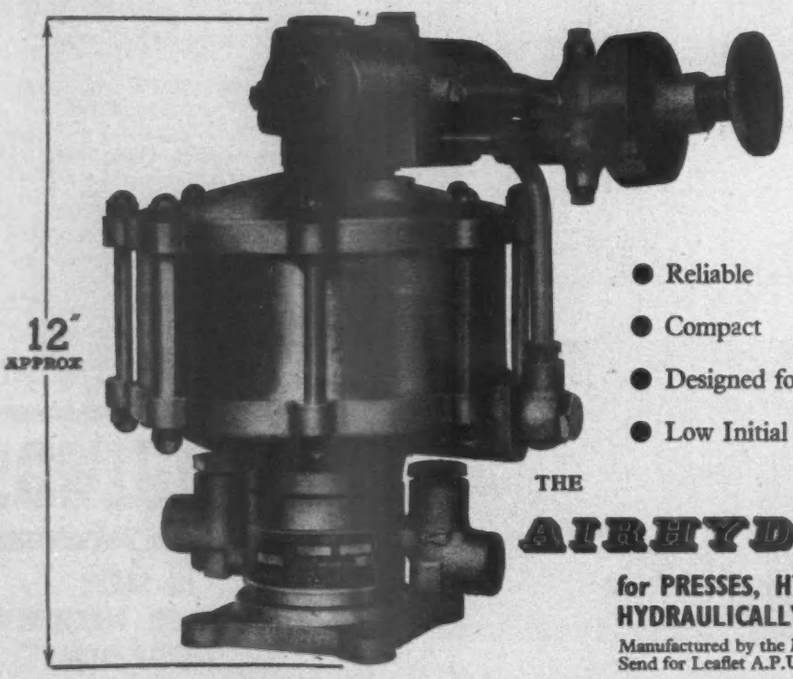
CORY BROTHERS & CO LTD

CORYS' BUILDINGS · CARDIFF · Telephone: Cardiff 31141

★ Control torque application automatically
★ Make overloading impossible
★ Do not depend on the vision, care or skill of the operator for their accuracy
★ Are unaffected by side loads
★ Give precision results with unskilled labour
★ Retain their accuracy for long periods of continuous use without attention

Sixteen models provide for loads up to 850 lbs/ft
Also Hydraulic Torque Generators for loads up to 3,000 lbs/ft

It's New! HYDRAULIC POWER



9 Models Give Pressure Range from **62-22,500** p.s.i.

Operated by Compressed Air from **5-100** p.s.i.

Weights from 50-81 lbs.

- Reliable
- Compact
- Designed for High Output
- Low Initial Cost
- Negligible Maintenance
- Non-Corrosive
- No Consumption of Air when maintaining Static Pressure

THE

AIRHYDRO POWER UNIT

for PRESSES, HYDRAULIC JACKS, HYDRAULICALLY LOADED ROLLS, etc.

Manufactured by the Makers of the World Famous 'AIRHYDROPUMP'
Send for Leaflet A.P.U. 1 complete with Output Graphs

CHARLES S. MADAN & CO. LTD.

Vortex Works Atlantic Street Altrincham Cheshire
Telephone Altrincham 2702 (3 lines)

206

DARWINS *Quality* STEELS

TOOL STEEL TREATMENT INSTRUCTIONS

Tool Steel	Application	Hardening	Tempering	Service Hardness	Uses and Characteristics
		950/980°C. Quench	200/220°C.	60/65 Rock "C"	Non-distorting, abrasion and corrosion resistant steel for press tools and dies, thread rolls, gauges, etc.
		1020°C. Oil	200/220°C.	60/63 Rock "C"	Non-distorting and corrosion resistant steel for press tools milling cutters, plastic moulds, gauges.
		C.	150/200°C.	58/60 Rock "C"	Plastic moulding dies, blanking dies, plungers, punches, etc.
			200/220°C.	57/58 Rock "C"	Surgical instruments, dies, machine knives, etc.
			200/220°C.	56/58 Rock "C"	Chisels, punches, shear blades, pneumatic tools, etc.
			200/220°C.	58/62 Rock "C"	As Meer but more suitable for working under severe conditions
		None		53/57 Rock "C"	Chisels, cutters, snaps, gauges, punches, etc. self tempering.
		None		53/57 Rock "C"	Chisels, shear blades, pneumatic tools, etc., to withstand high shock resistance.
		for work. 200°C. work. hched		53/57 Rock "C" 49/46 Rock "C"	Chisels, shear blades, pneumatic tools, etc., for hot or cold work, high fatigue resistance non-distorting. Also in wide use for plastic moulds.
				50/52 Rock "C"	Chisels, cutters, snaps, gauges, punches, etc.
				45/50 Rock "C"	Pressure moulds for die-casting of Al base alloys, hot forming and stamping dies, hot Shears, etc.
				46/46 Rock "C"	Extrusion dies, hot drawing dies. Wear resistant hot work steel.

DARWINS LIMITED
FITZWILLIAM WORKS, SHEFFIELD, 9
Makers of Fine Steels
THE DARWINS GROUP
STAINLESS STEELS
HEAT RESISTING ALLOYS
THERMAL EXPANSION ALLOYS
INCLUDING
HIGH SPEED STEELS
TOOL STEELS - HOT & COLD WORK
CHISEL STEELS

CONVERSION VALUES OF HARDNESS SCALES AND APPROXIMATE TENSILE STRENGTH

Diam. mm.	Brinell Hardness No.	Brinell Calculated Tonnage	Vickers Hardness No.	Rockwell "B" 1/16" ball	Rockwell "C" 120° Diamond cone	Scleroscope
2.20 2.25 2.30 2.35	388 375 363 352	131 127 123 119	388 375 363 352			
2.35 2.40 2.45 2.50	341 331 321 311	115 112 108 105	341 331 321 311			
2.50 2.55 2.60 2.65	302 293 285 277	102 99 96 94	302 293 285 277			
2.65 2.70 2.75 2.80	269 262 255 248	91 89 86 84	269 262 255 248			
2.80 2.85 2.90 2.95	241 235 229 223	81 79 77 75	241 235 229 223			
2.95 3.00 3.05 3.10	217 212 207 201	73 71 70 68	217 212 207 201			
3.10 3.15 3.20 3.25	197 192 187 183	66 65 63 62	197 192 187 183			
3.25 3.30 3.35 3.40	179 174 170 167	60 59 57 56	179 174 170 167			
3.40 3.45 3.50 3.55	163 159 156 152	55 54 53 51	163 159 156 152			
3.55 3.60 3.65 3.70	149 146 143 140	50 49 48 47	149 146 143 140			
3.70 3.75 3.80 3.85	137 134 131 128	46 45 44 43	137 134 131 128			
3.85 3.90 3.95 4.00	126 123 121 118	42 41 40 39	126 123 121 118			
4.00 4.05 4.10 4.15	116 114 111 109	39 38 37 36	116 114 111 109			
4.15 4.20 4.25 4.30	107 105 103 101	36 35 34 33	107 105 103 101			
4.30 4.35 4.40 4.45	99 97 95 93	33 32 32 31	99 97 95 93			
4.45 4.50 4.55 4.60	92 90 88 86	31 30 29 29	92 90 88 86			
4.60 4.65 4.70 4.75	85 83 82 80	28 28 27 27	85 83 82 80			
4.75 4.80 4.85 4.90	79 78 76 75	26 26 25 25	79 78 76 75			

Write today for Heat Treatment Chart and Booklet

TOOL STEELS
DARWINS LIMITED · SHEFFIELD

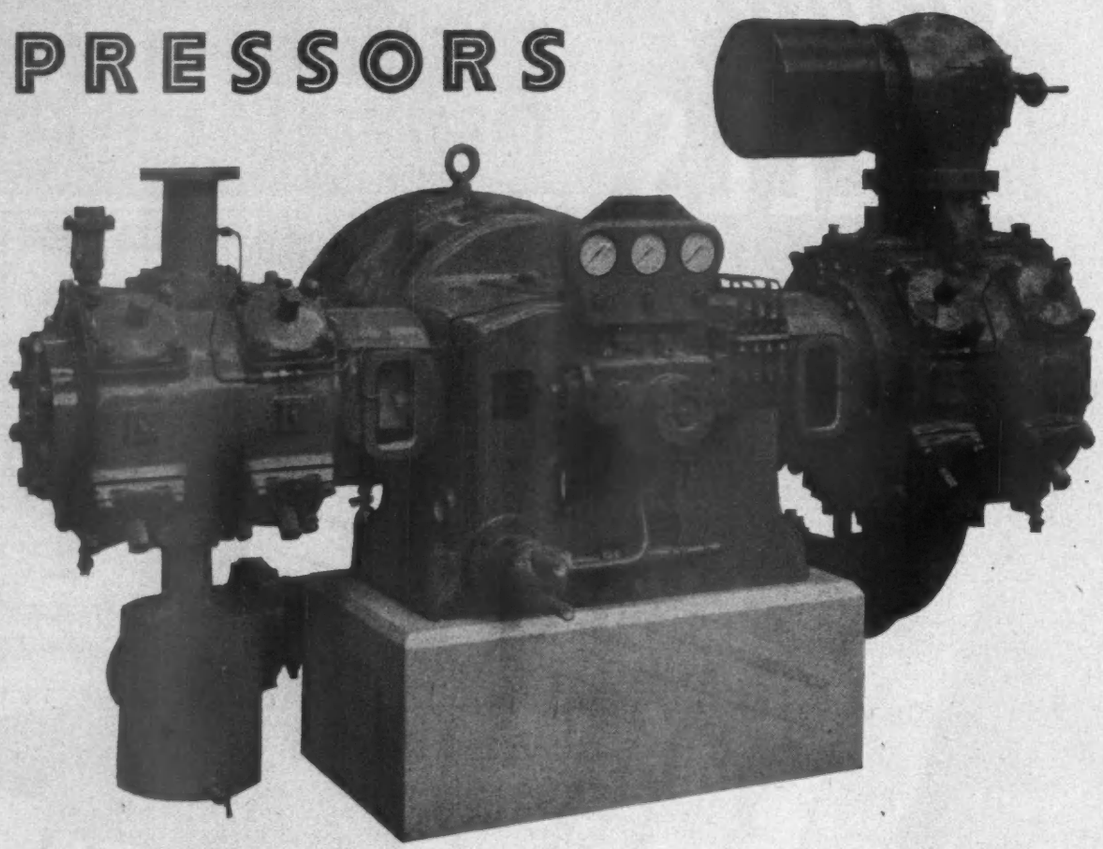
THE DARWINS GROUP

DARWINS LTD · TINSLEY · SHEFFIELD · 9 ·

D.101

ALLEY

BALANCED OPPOSED COMPRESSORS



The long established high quality of Alley Compressors is combined in these machines with the known advantages of the horizontally-opposed design.

COMPACTNESS: Intercooler lies below motor. Motor is built on.

BALANCE: No horizontal or vertical out-of-balance forces.

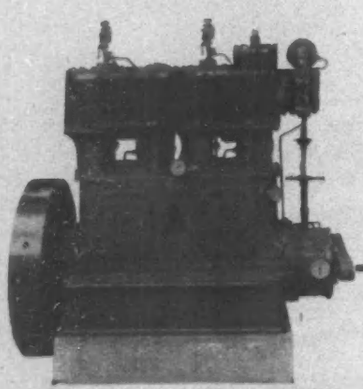
FREEDOM FROM VIBRATION

Can be installed on a minimum foundation—even on an upper floor.

The unit is complete—intercooler and oilcooler incorporated—ready for bolting down.

Range of single and two stage machines from 400 to 2000 c.f.m.

A corresponding range of VACUUM PUMPS is available with displacements up to 3,000 c.f.m.



ALLEY & MACLELLAN (POLMADIE) LTD.,
GLASGOW, S.2.

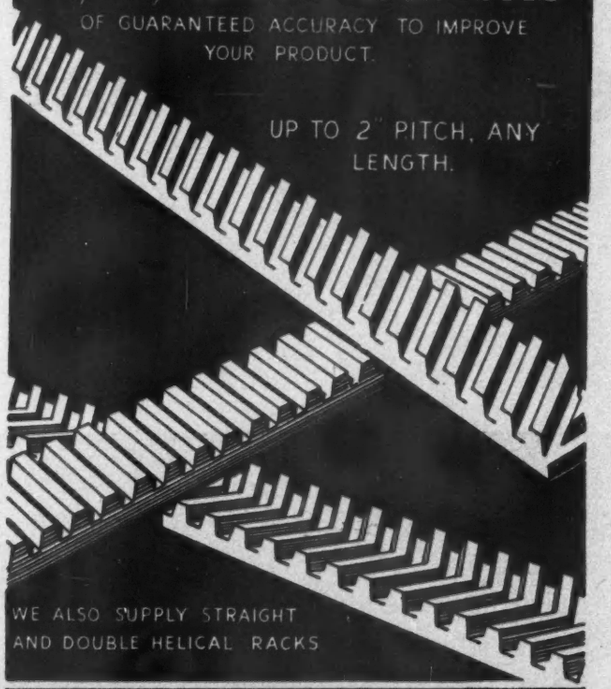
Licensed to manufacture Gas Compressors to the designs of Clark Bros. Co., Olean, U.S.A.

THE ALLEY B/L STEAM ENGINE: A high class range of single and two cylinder engines of compound and non-compound type, with outputs ranging from 40 B.H.P. to 750 B.H.P.

Specify HELICAL RACKS

OF GUARANTEED ACCURACY TO IMPROVE YOUR PRODUCT.

UP TO 2" PITCH, ANY LENGTH.



WE ALSO SUPPLY STRAIGHT AND DOUBLE HELICAL RACKS

BARLOW & CHIDLAW LTD
PENDLETON · MANCHESTER. 6.

What do you do with your waste oil?

WELLS FILTERS enable waste oil to be used with complete confidence many times over.

give old oil NEW LIFE

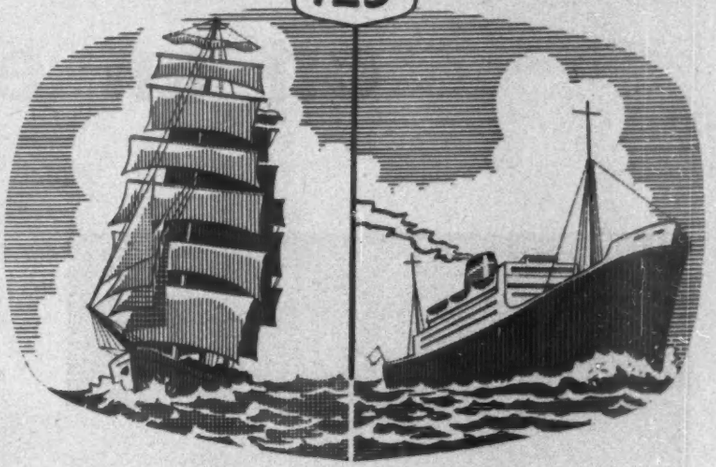
The Wells special filter pads used in conjunction with the Wells patent syphon feed make waste oil clean again.

A. C. WELLS & CO., LTD

MOUNT ST., HYDE, CHESHIRE

Tel: HYDE 2953 GRAMS: UNBREAKABLE HYDE

AFTER 125 YEARS



ALL METALWORKING TRADES still demand COATED ABRASIVES by

OAKEY

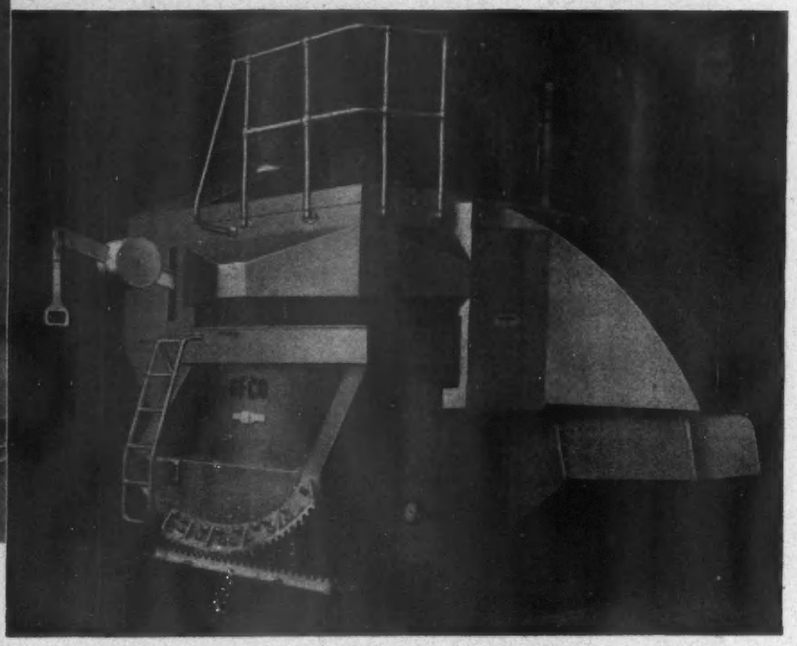
IN ROLLS · BELTS · DISCS & SHEETS

ESTABLISHED 1833

John Oakey & Sons Ltd · Wellington Mills · London SE1

OA51C

Fume control on an electric furnace



Photographs by courtesy of North British Steel Foundry Ltd.

Fume from the furnace is closely controlled by the fitted hood, which remains in place no matter to what angle the furnace is tilted. Easily removable subsidiary hoods over the pouring spout and the slagging door form a part of the complete unit and can be lifted off without disturbing the main hood for door and lining repairs.

TILGHMAN'S LIMITED

DUST AND FUME CONTROL DIVISION

BROADHEATH ALTRINCHAM CHESHIRE

London Office: 1 Chester Street, S.W.1.

A member of the Staveley Coal & Iron Co. Ltd. Group.

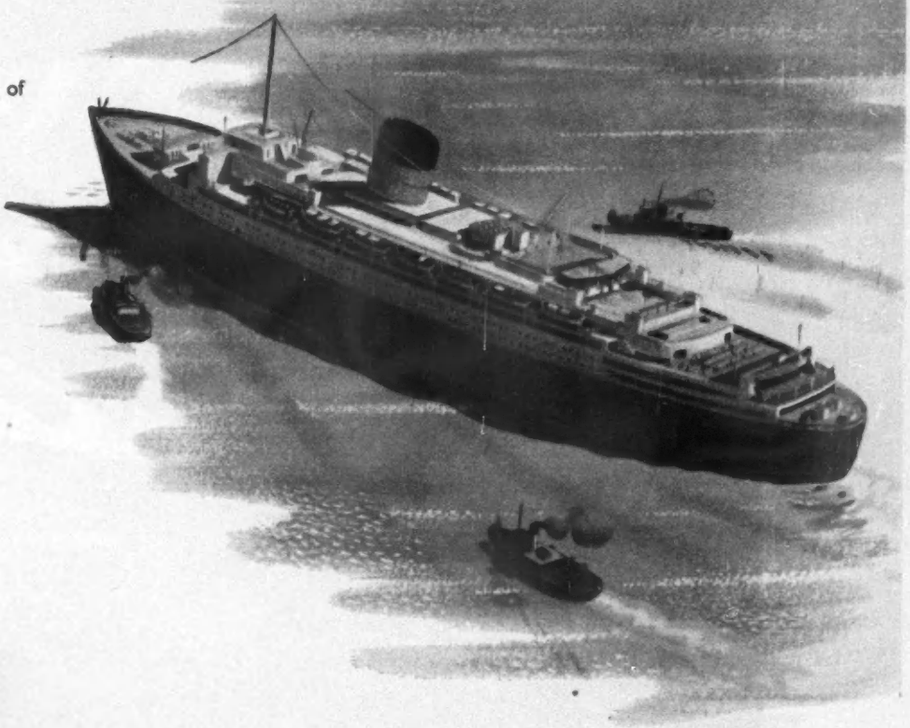
AGENTS: MIDLANDS: R. J. Richardson & Sons Ltd., Commercial Street, Birmingham 1

SCOTLAND: Balbardie Ltd., 227 Bath Street, Glasgow C.2; 110 Hanover Street, Edinburgh 2

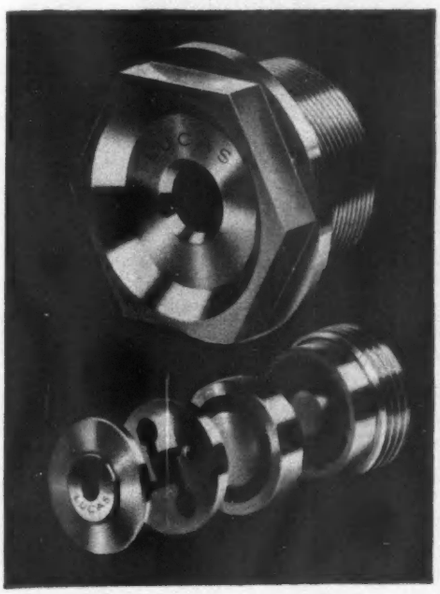
NORTHERN IRELAND: Stewart Industrial Services Ltd., 16 Sussex Place, Belfast

W137

LIQUID FUELS REQUIRE SPECIAL BURNING TECHNIQUES



Lucas has unrivalled knowledge of the burning of liquid fuels. This knowledge has been gained over years of research and development in world-wide applications. A range of atomisers for oil burning appliances is now available and includes units suitable for flows of 2 gallons per hour to the largest boiler installations of marine ocean going vessels with flows up to 5000 lbs/hr. Calibrated to handle fuel oils of 35 seconds to 12,000 seconds viscosity suitably pre-heated at varying spray angles according to particular requirements.



LUCAS

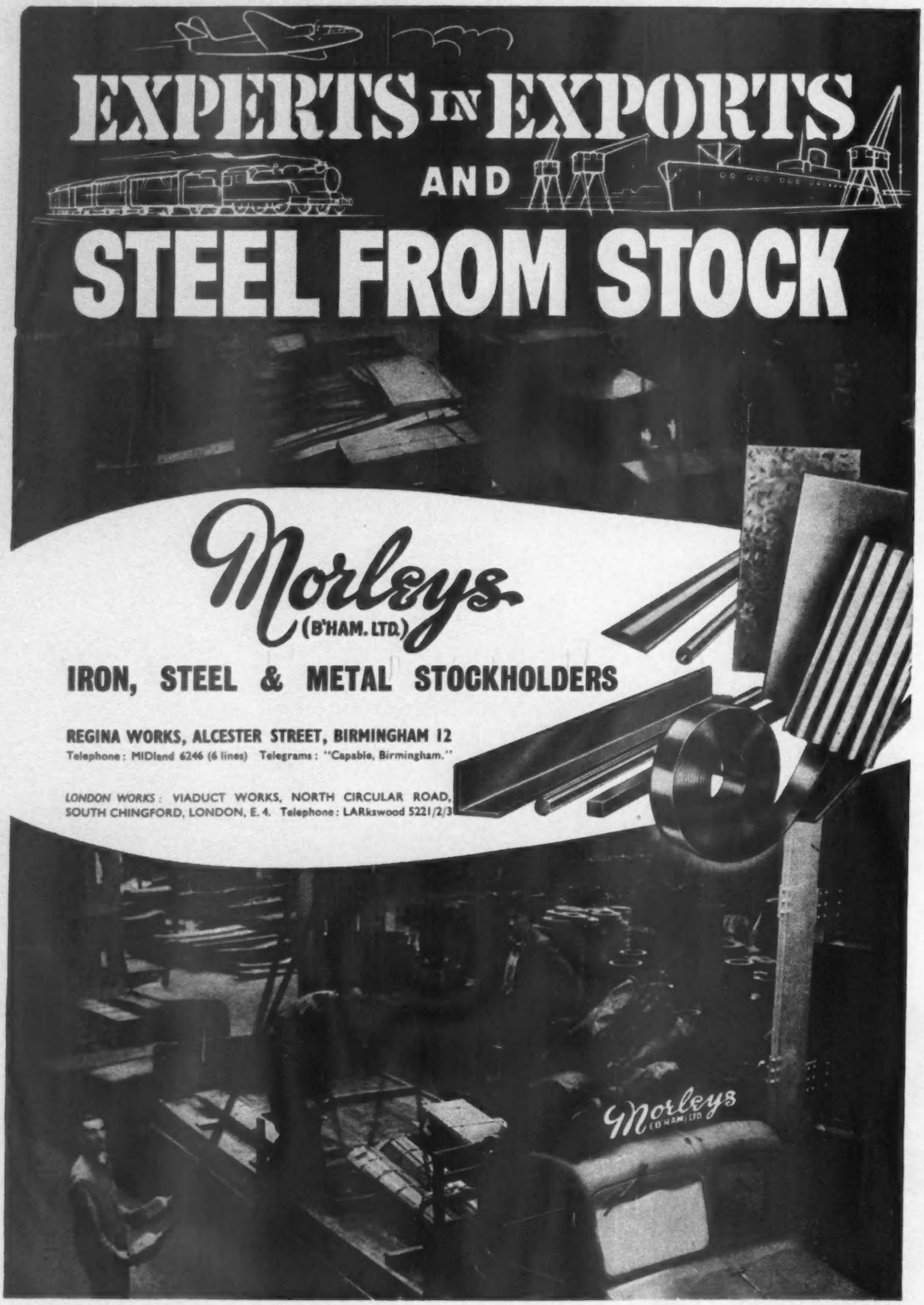
ATOMISERS

FOR OIL FUEL BURNING APPLIANCES

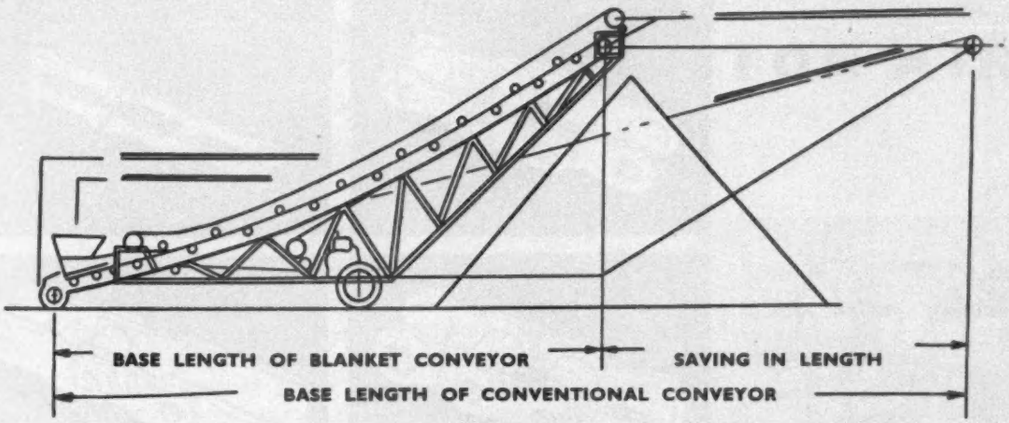
Consult our Technical Sales Department for advice and assistance

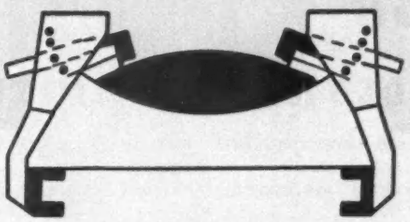
JOSEPH LUCAS (HYDRAULIC & COMBUSTION EQUIPMENT) LTD., MARSTON GREEN · BIRMINGHAM · ENGLAND

A subsidiary of JOSEPH LUCAS (INDUSTRIES) LIMITED


EXPERTS IN EXPORTS
AND
STEEL FROM STOCK
Morleys
(B'HAM. LTD.)
IRON, STEEL & METAL STOCKHOLDERS
REGINA WORKS, ALCESTER STREET, BIRMINGHAM 12
Telephone: MIDland 6246 (6 lines) Telegrams: "Capable, Birmingham."
LONDON WORKS: VIADUCT WORKS, NORTH CIRCULAR ROAD, SOUTH CHINGFORD, LONDON, E. 4. Telephone: LARkswood 5221/2/3
Morleys
(B'HAM) LTD

MAKE A NOTE OF THE NAME — YOU'LL DO BETTER AT MORLEYS!





section through conveyor

The "blanket" conveyor (built under licence from the North Thames Gas Board) is a simple arrangement of two continuous belts running one above the other. The lower side of the upper belt runs with the upper side of the lower belt, forming a tubular cross-section. The edges of the belts are held together by idlers above and below the belt run. A portable version of the design is illustrated here.

maximum elevation

PLUS...

- less cost per foot rise
- shorter, lighter construction
- increased manœuvrability
- reduction of dust nuisance

The illustration shows the "blanket" conveyor elevating granular material at 40° as compared with the 18° inclination of a conventional conveyor.

BIRTLEY

PORTABLE blanket conveyor

BIRTLEY ENGINEERING LIMITED

MEMBER OF THE B.S.A. GROUP

REGISTERED OFFICE BIRTLEY Co DURHAM *Phone Birtley 248/9 Grams Birtley Newcastle-on-Tyne*

COAL PREPARATION PLANT DEPT MARKET PLACE CHAMBERS WEST BARS CHESTERFIELD
Phone Chesterfield 4116 (2 lines) Grams Birtley Chesterfield

LONDON OFFICE CLARIDGE HOUSE DAVIES STREET LONDON W1 *Phone Mayfair 4157*

P.1800

In 1879

Hans Renold invented the precision roller chain

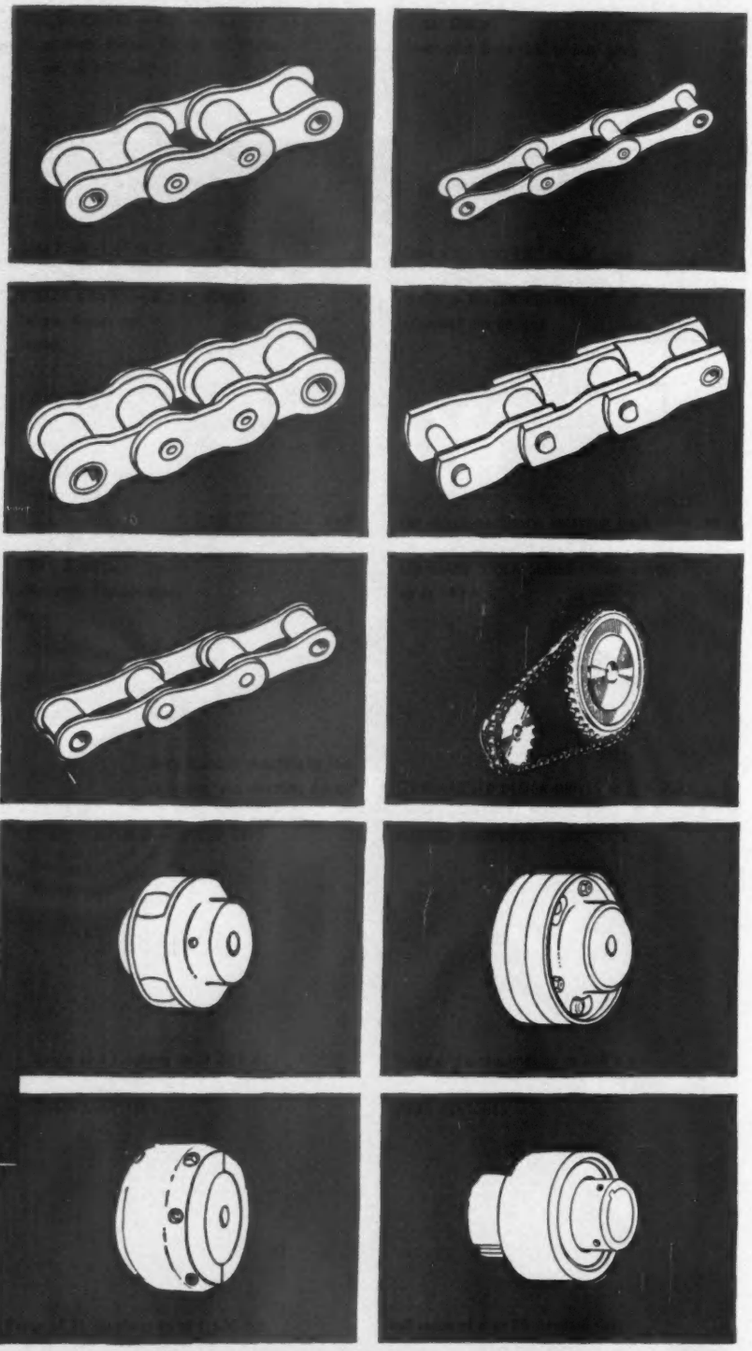
In 1958

RENOLD CHAINS LIMITED

offer an unequalled range of quality-engineered products for all your transmission and conveying requirements.

80 years' experience in the perfection of chain design and application is at your disposal. Whether your problem is one of replacement, conversion or prototype design, make use of this unparalleled fund of "know-how" by calling in

RENOLD



Our engineers are always available for consultation. Write for appropriate literature or contact them at:-

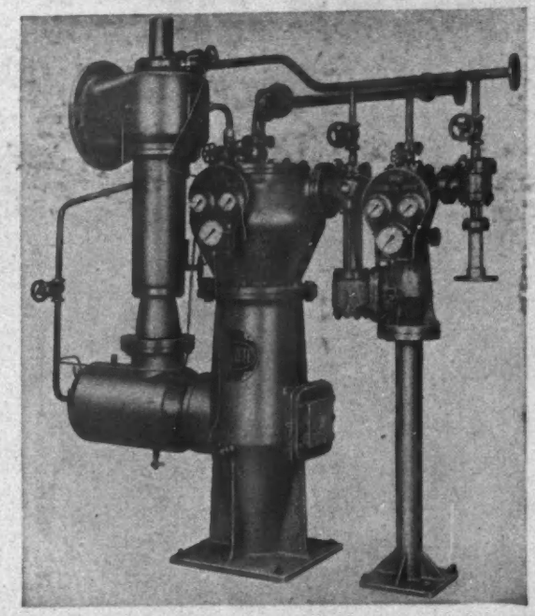
		Telephone and Telegrams:
BIRMINGHAM, 3	144 Great Charles Street	CENtral 2404
BRISTOL, 8	Office: 16 Whiteladies Road Stock Depot: 2 St. Paul's Road	Bristol 33027
CARDIFF	Stock Depot: 68 Bute Street	Cardiff 22860
GLASGOW, C.2	26 Blythswood Square	CITy 5411
LEEDS, 1	13-14 Park Place	Leeds 22746
LEICESTER	86 London Road	Leicester 58131
LONDON, W.C.2	Bush House, Aldwych	HOLborn 5371 (Telegrams: "Driving, Telex", London)
MANCHESTER, 21	102 Manchester Road, Chorlton-cum-Hardy	CHOrlton 5393
NEWCASTLE-UPON-TYNE	50-52 Scotswood Road	Newcastle 24185
		Telephones:
BELFAST	Henry R. Ayton Ltd., 47 Queen Street	Belfast 29834
DUBLIN	Henry R. Ayton Ltd., 20 Harcourt Street	Dublin 51335

REPRESENTATION THROUGHOUT THE WORLD

RENOLD CHAINS LIMITED • MANCHESTER

Mirrlees'

EJECTOR AIR PUMPS



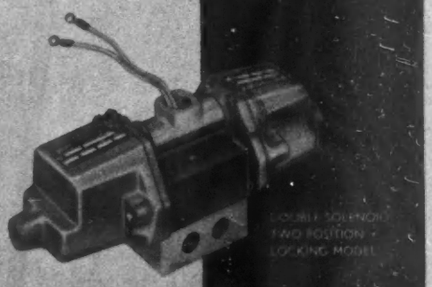
This is one of the many types of "Mirrlees" ejector air pumps.

The steam operated ejector has been a speciality of the Mirrlees Watson Company since its introduction as an air pump, and we claim a large share of the credit for the almost universal adoption of this type of apparatus for air extraction, and the production of vacuum in modern condensing plants and other industrial processes where pressures less than atmosphere are required.

THE
MIRRLEES WATSON
COMPANY LIMITED

Head Office and Works: SCOTLAND ST., GLASGOW, C.5
London Office: 38, Grosvenor Gardens, S.W.1

Ross COMET



A NEW PACKLESS VALVE

FOR

PNEUMATIC & HYDRAULIC APPLICATIONS

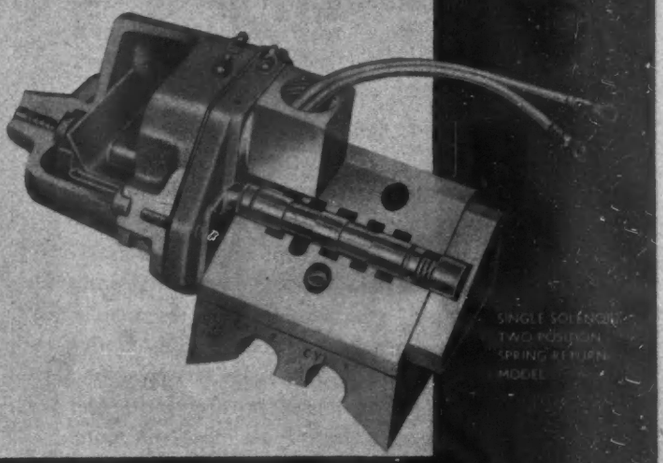
PRESSURE RANGE 0-250 P.S.I.

Direct Solenoid Operated. Lightweight. Fast Operation

Size range 1/4in. — 3/8in. B.S.P. A.C. or D.C. Supply. Dust-tight Cover

Ample Wiring Space. Captive Cover. Swivel Conduit Connection

Balanced Spool. Can be Manually Operated

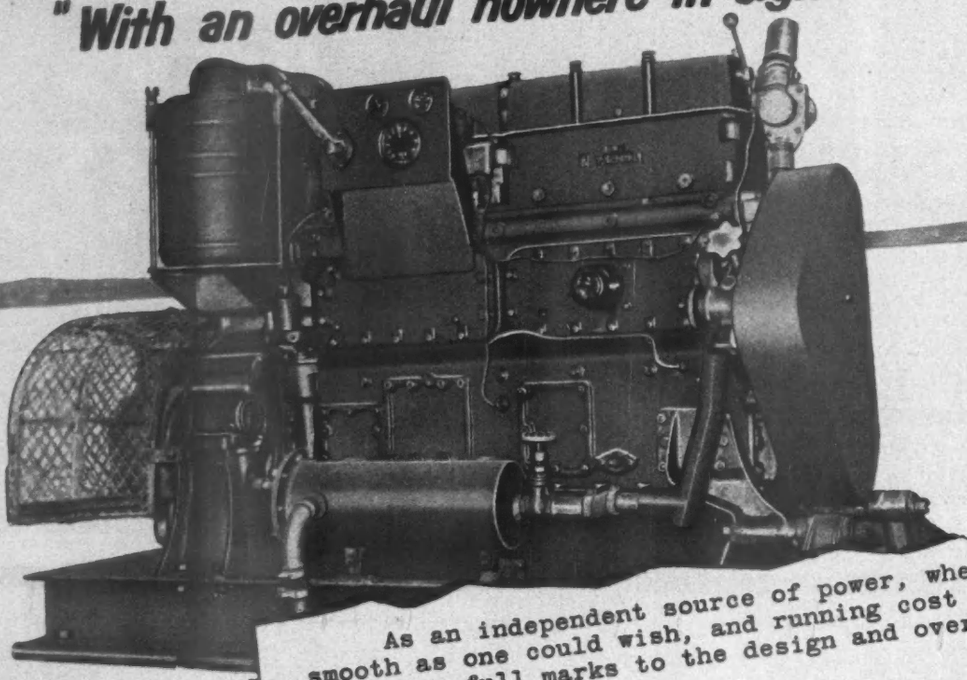


Write for Bulletin 311, to:

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD.
PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS: DARLASTON, South Staffs, & BELFAST.

35,000 HOURS of SERVICE

"With an overhaul nowhere in sight"



As an independent source of power, where torque is as smooth as one could wish, and running cost at a minimum we must give full marks to the design and overall efficiency of this engine.

The full tale is not yet told. We anticipate to add to this excellent record at some future date.

Please accept our congratulations.

Yours sincerely,
Jordon M. Gwilliam,
J. Gwilliam Ltd.

100 hours of continuous trouble-free running, every week for seven years. That's the record of the 6 cylinder 0.600 Leyland industrial engine operated by J. Gwilliam Ltd., at their Coultershaw Mill, Petworth.

Apart from maintenance of injectors and valves . . . oil filters changed regularly and the use of a good lubricant, no other work has been found necessary.

With pistons and cylinder walls in excellent condition, this engine, in the opinion of the operator " is due for many more thousands of hours before a major overhaul will be needed ".

Such a testimonial to Leyland efficiency is naturally pleasing—but not surprising. For when you ally 25 years of diesel specialisation to the resources of one of the world's largest organisations in this particular field, plus an after-sales service second to none—then the result must be exceptional. And Leyland engines are certainly all that—and more.

Leyland

ENGINES

The Greatest Moving force in Industry

From 80 h.p to 230 h.p.

LEYLAND MOTORS LTD · LEYLAND · LANCS

OPEN FRONTED PRESSES

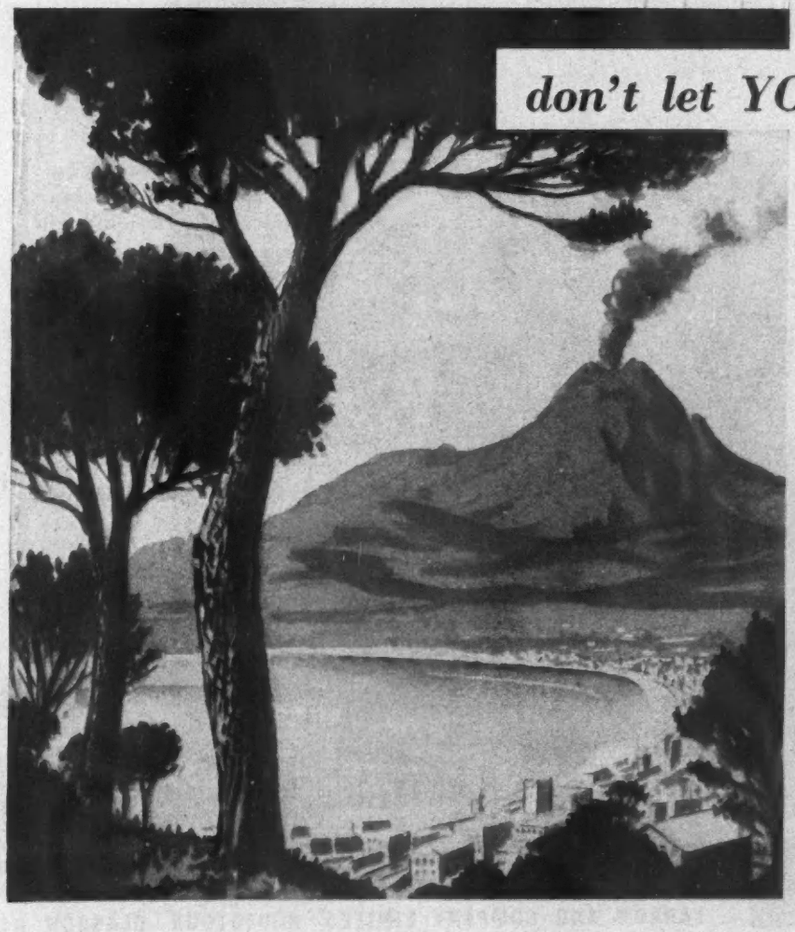
UP TO 180 TONS PRESSURE

WE ALSO MAKE

Power Screw Presses
Double Action type Drawing Presses
Double sided Presses
Single and Double Crank Presses
All types of Automatic Feed Presses
Minting machinery
Cartridge machinery

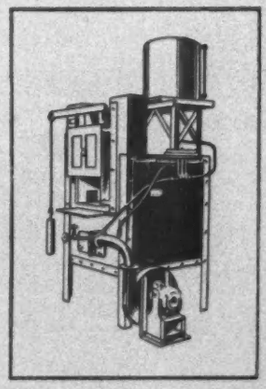
100 ton Inclinable Press

TAYLOR & CHALLEN LTD BIRMINGHAM 19



don't let YOUR heat go to waste . . .

ALCOSA furnaces and forges are specially designed to make the best possible use of heat from oil and gas—a sure way to reduce costs.



MODEL No. O F 600 FURNACE

A highly efficient furnace for case hardening, annealing, rivet heating and general heat treatment, oil or gas fired. Soundly constructed with extra heavy furnace lining, assuring heat conservation and reduced fuel consumption. Special flue construction eliminates scaling.

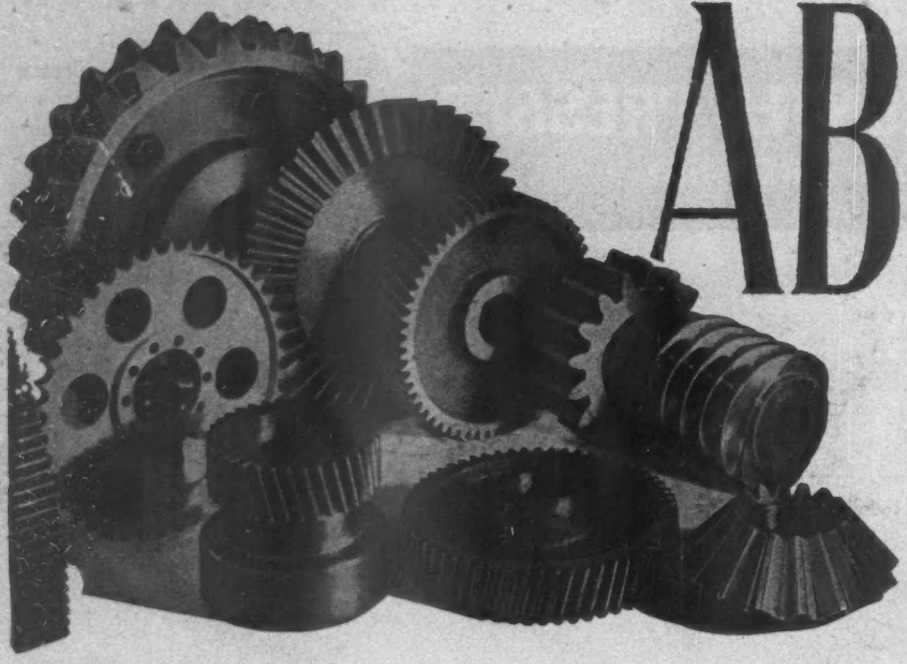
...make the most of it with...

ALCOSA products include: Blowers, brazing equipment, gas and oil burners, furnaces, portable forges, soldering and tinsmith equipment, etc.

BRITISH ALCOSA PRODUCTS

FURNACES & FORGES

WILLIAM ALLDAY & CO. LTD.
Alcosa Works, Stourport-on-Severn, Worcs. *Tel*: Stourport 2311-4



ABBOT

Machine Cut GEARS

of all kinds—
to specification in any material.

We guarantee the teeth of all wheels cut by us to be correct, and all work is examined and checked before being despatched. Each gear wheel of a pair is run in correct relative position to the other in a special gear-testing machine. No perceptible backlash is allowed in our gearing, and thus we can ensure very silent running.

Our booklet "MACHINE CUT GEARS" contains much information of interest and use to engineers. A copy will be sent on request.

Uniformly Fine Gears

The ABBOT ENGINEERING Co. Ltd.,
22 SMITHHILLS PAISLEY
Telephone: PAISLEY 4272. Telegrams: "ABBOT, PAISLEY."

SPUR WHEELS · SPIRAL WHEELS · RACKS · WORM GEARING · BEVEL WHEELS · FIBRE PINIONS

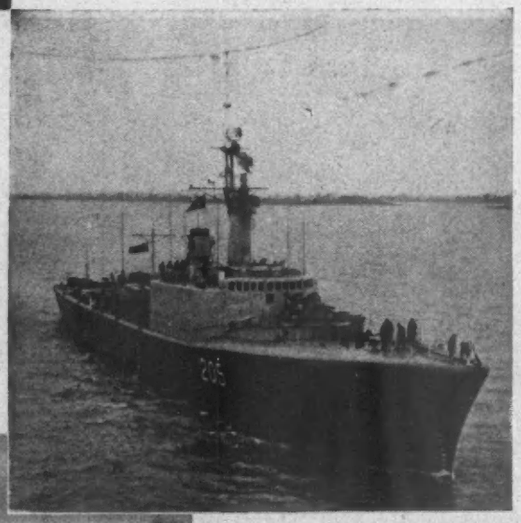
YARROW

shallow draft vessels, land and marine boilers

SHIPBUILDERS

ENGINEERS

BOILERMAKERS



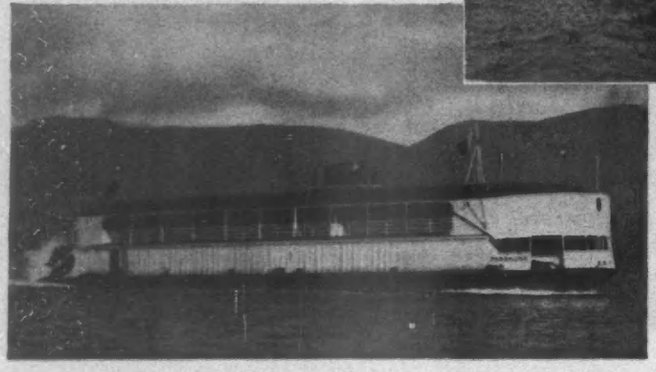
For ninety years Yarrow & Company Ltd have specialised in the design and construction of naval ships and shallow draught vessels of all types.

Yarrow Water Tube Boilers are installed in many of the world's largest and most modern Power Stations. Likewise, many of the world's most famous ships have boilers of Yarrow design.

A Research Department is fully engaged in the design and development of high power propulsion machinery and nuclear activities are playing an increasing part in the work of this Department.

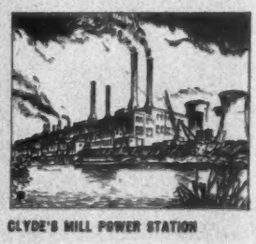
HMCS ST LAURENT *Anti-submarine destroyer escort vessel. Machinery installation designed and supplied by Yarrow.*

PONDAUNG *One of five quarter wheel motor passenger vessels for service on the Irrawaddy.*



ROOSEGOTE POWER STATION

BULAWAYO POWER STATION



CLYDE'S MILL POWER STATION

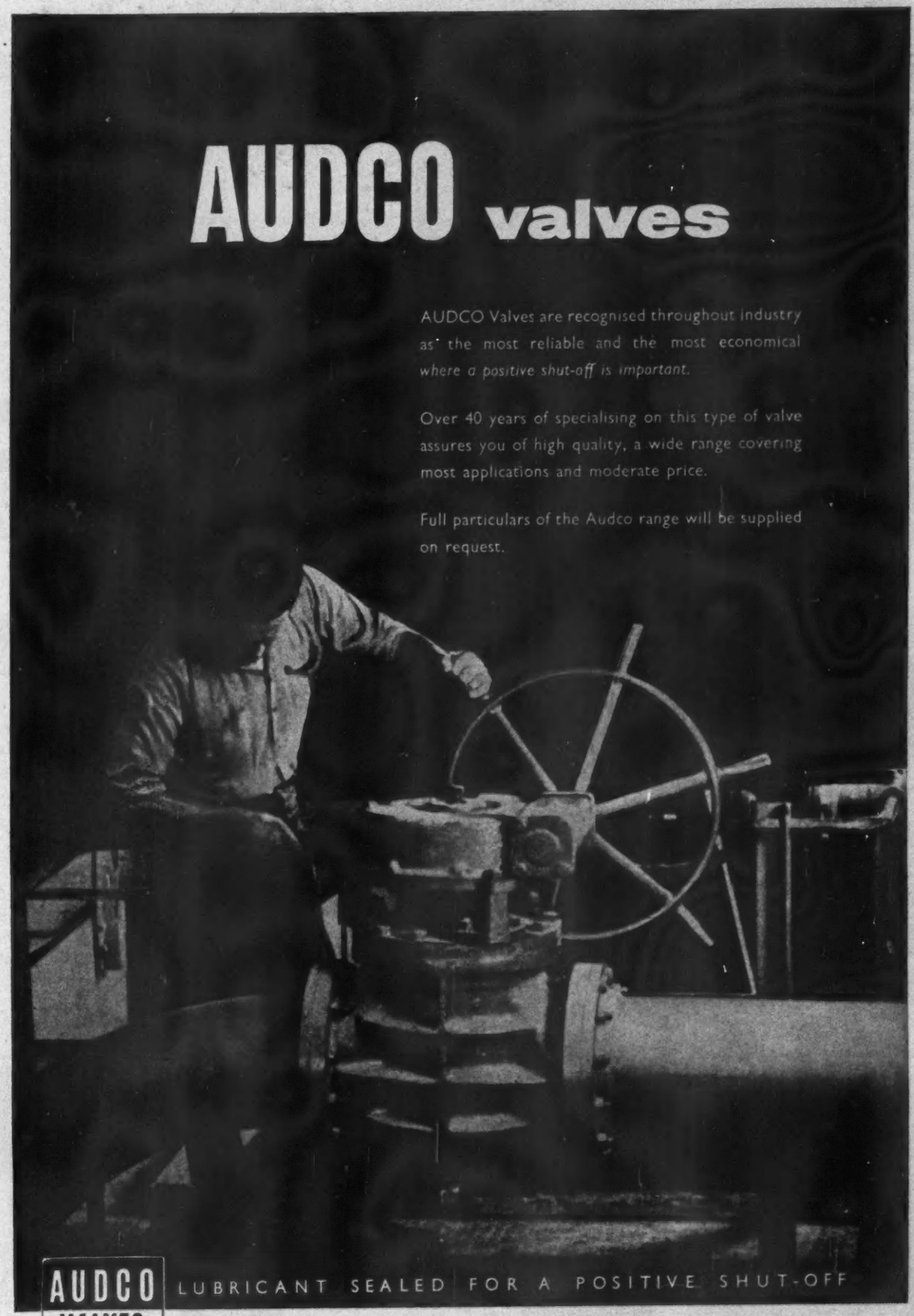
YARROW AND COMPANY LIMITED · SCOTSTOUN · GLASGOW W4

AUDCO valves

AUDCO Valves are recognised throughout industry as the most reliable and the most economical *where a positive shut-off is important.*

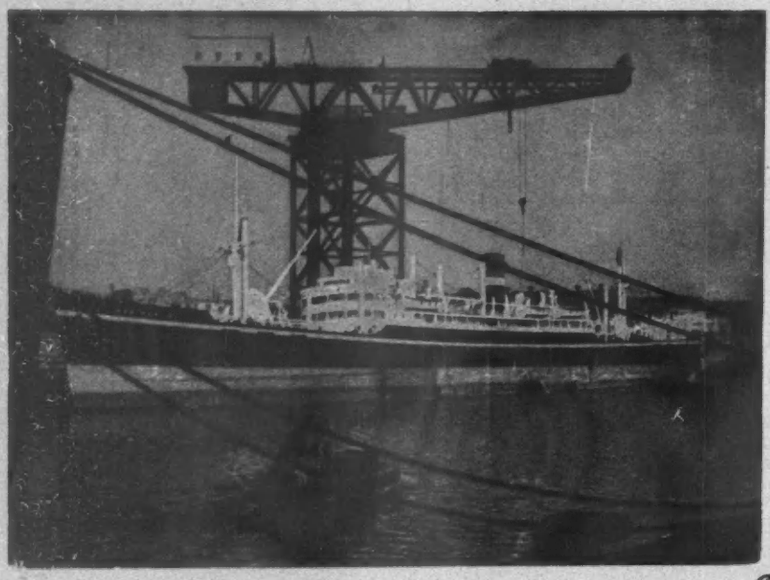
Over 40 years of specialising on this type of valve assures you of high quality, a wide range covering most applications and moderate price.

Full particulars of the Audco range will be supplied on request.



AUDCO VALVES LUBRICANT SEALED FOR A POSITIVE SHUT-OFF

AUDLEY ENGINEERING CO., LTD., NEWPORT, SHROPSHIRE



Facilities of
the first class for
Ships and Cargoes—
Foreign and Coastwise

Direct Shipments to and from

The **PORT OF GLASGOW**

on the River Clyde, serve at attractive charges

INDUSTRIAL SCOTLAND

and adjoining territory.

Write General Manager and Secretary

THE CLYDE NAVIGATION TRUST · 16 ROBERTSON ST., GLASGOW C.2

TELEPHONE—CENTRAL 2695

These integrators are instruments for the measurement of areas and moments of areas of plane figures, and can also be used in the determination of centres of gravity, volumes and moments of solids of revolution, etc.

Their application to many problems in Naval Architecture, Structural, Mechanical, Civil and Aeronautical Engineering greatly expedites the work while achieving a high order of accuracy—the precision of the instrument in most cases being greater than that with which the outline of the figure can be traced by a careful operator.

STANLEY

INTEGRATORS

W. F. STANLEY & Co., Limited.

Head Office and Main Works:—

NEW ELTHAM - - LONDON, S.E.9

Telephone: Eltham 3836 *Telegrams: "Turnstile Sesphone," London*

Showrooms:

79/80, High Holborn, London, W.C.1

Branches:

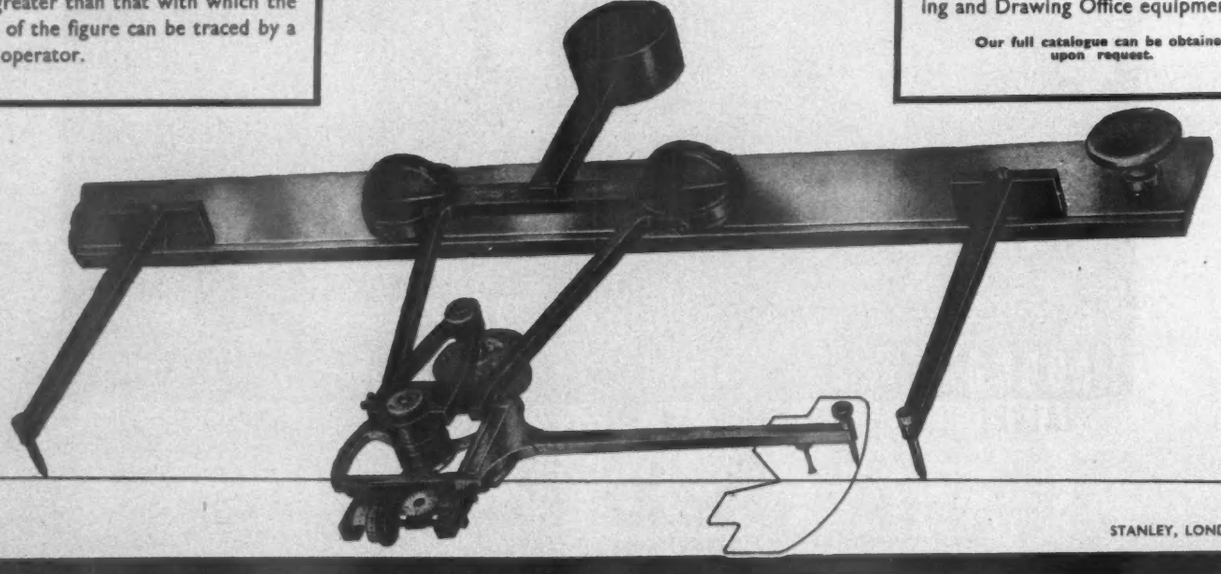
13, Railway Approach, London Bridge, S.E.1 52, Bothwell St., Glasgow, C.2

The illustration is that of our No. 1 model, and three models are available. Stanley Integrators can be supplied to give readings in either English (inch) or Metric units.

Send for illustrated literature giving full details.

The "Stanley" range of instruments includes Theodolites, Levels, Harmonic Analysers, Integraphs, Planimeters, Pantographs, Drafting Machines, Surveying and Drawing Office equipment.

Our full catalogue can be obtained upon request.



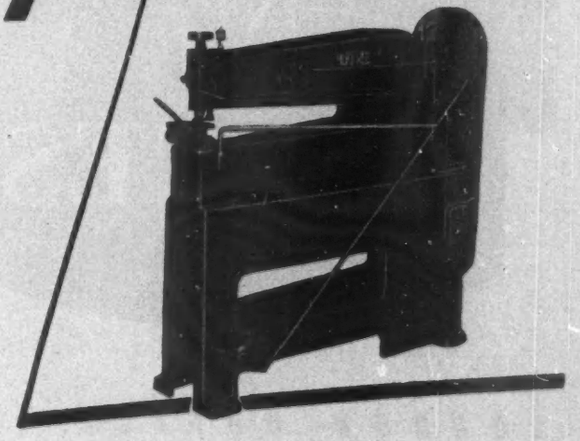
STANLEY, LONDON

REGD.
BURFREE
TRADE MARK

1 machine...

SHEARING
NIBBLING
TUBE CONTOURING
FLANGING, FORMING
LOUVRING
BEADING

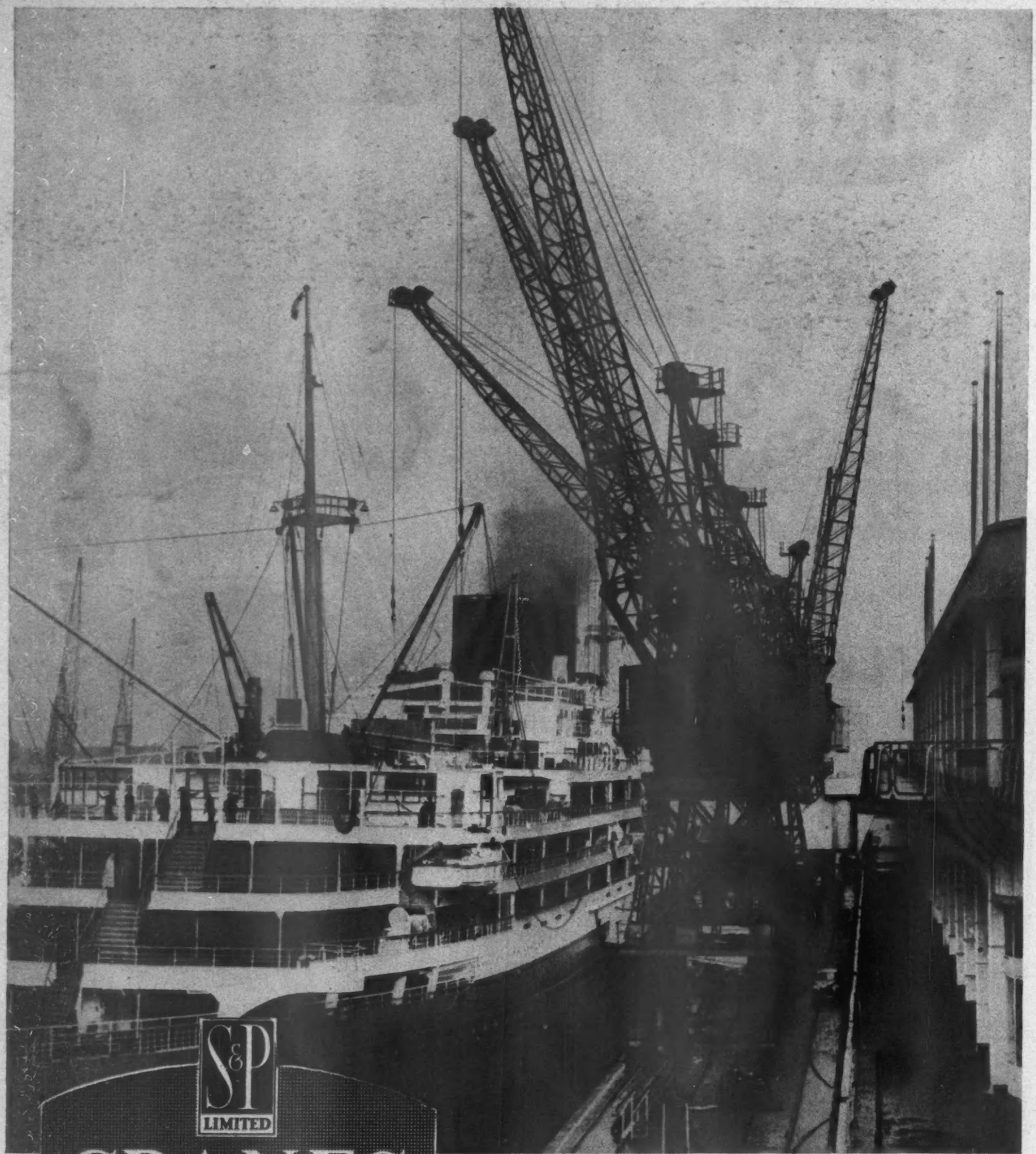
6 operations



J. B. STONE & CO. LTD.
(Engineers)

BURGESS HILL
Phone : Burgess Hill 85631/2/3

SUSSEX
Grams : Sightseer, Burgess Hill



S&P LIMITED

CRANES

FOR THE WORLD'S PORTS

STOTHERT & PITT LTD

BATH · ENGLAND

LONDON OFFICE: 38, VICTORIA STREET, S.W.1

Mr Urge

& Mr Surge

The sketches are of bronze figures known as The Little Warriors, from Western Mexico.

For motors with the mostest urge
And pumps with punch (but not with surge),
You can't go wrong in specifying
Hayward Tyler, when you're buying.

Water engineers of vision,
Men who harness nuclear fission,
Scientists from every quarter,
Wanting light or heavy water,
All agree (as you have guessed)
That Hayward Tyler pumps* are best.

**HAYWARD TYLER*
Borehole pumps
Glandless pumps
Oil refinery pumps
Oil cargo pumps
Steam turbines

HAYWARD TYLER

& CO. LTD. P.O. BOX 2 LUTON PHONE: 6820

LONDON OFFICE: SALISBURY HOUSE FINSBURY CIRCUS E.C.2 NATional 9306

D

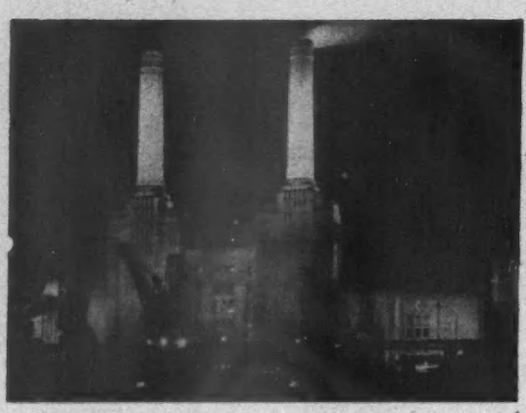
CIMENT FONDU
is the Ideal Cement for
CHIMNEY LININGS

—Used according to temperature conditions with Refractory, Insulating or Non-Refractory aggregates.

—It protects the steel, brick or concrete structure against attack by heat and by the acidity and sulphates from the combustion gases.

Wallasey Power Station. Ciment Fondu mortar was used for the jointing of the interior brickwork of this chimney.

Shell's Shellhaven Refinery, Essex. These 9 ft. diameter steel stacks have been lined with Ciment Fondu insulating concrete.



Battersea Power Station where chimneys have been lined with Ciment Fondu mortar.

Table Bay Power Station, South Africa. Chimneys gunited with Ciment Fondu mortar.

REFRACTORY CONCRETE
The adaptable Refractory material made with crushed firebrick and CIMENT FONDU

CIMENT FONDU
Regd. Trade Mark
ALUMINOUS CEMENT

The Cement for Industry

FOR SPEED · STRENGTH RESISTANCE · REFRACTORINESS

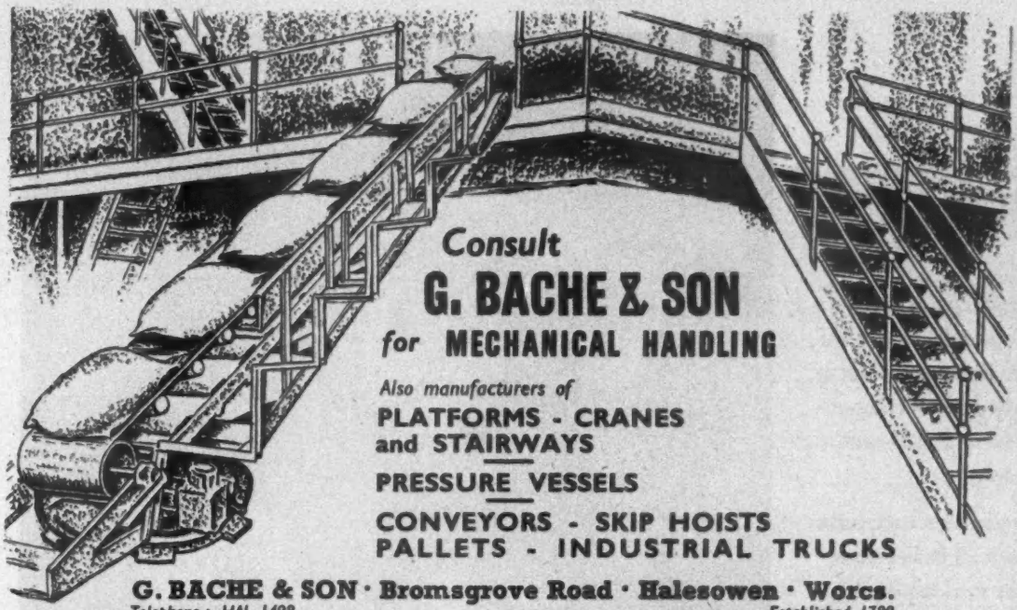
Ciment Fondu is manufactured by

LAFARGE ALUMINOUS CEMENT COMPANY LIMITED

73 BROOK STREET, LONDON, W.1. Telephone: MAYfair 8540

You are invited to write for further details and photographic examples

AP 3-1309



Consult
G. BACHE & SON
for **MECHANICAL HANDLING**

Also manufacturers of
PLATFORMS - CRANES and STAIRWAYS

PRESSURE VESSELS

CONVEYORS - SKIP HOISTS
PALLETS - INDUSTRIAL TRUCKS

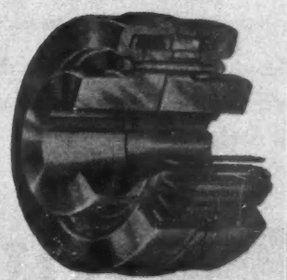
G. BACHE & SON · Bromsgrove Road · Halesowen · Worcs.
Telephone: HAL 1498 *Established 1780*

STEEL FRAME BUILDINGS
OF EVERY DESCRIPTION
Factories, Sheds, Mill Buildings, Foundries, Bungalows, Etc.
SPECIALITIES
Pit Headgear, Pumping Stations, Power Stations.

Bridgework and Riveted Work of all descriptions

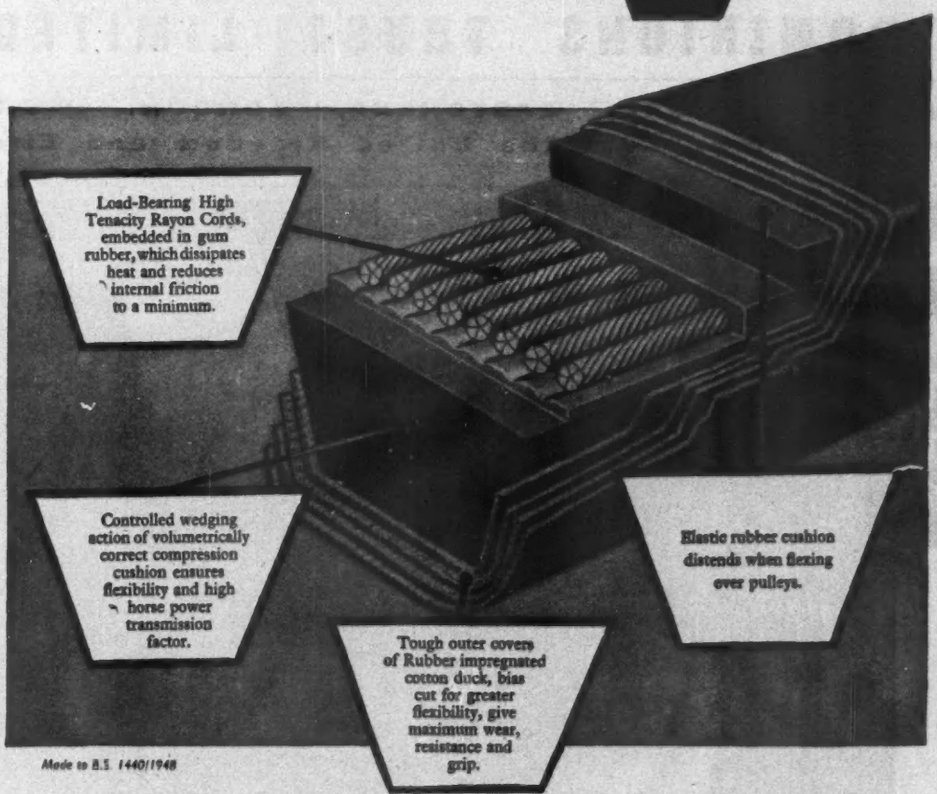
BROWNLIE and MURRAY LTD.
POSSIL PARK, GLASGOW
LONDON: 22, QUEEN VICTORIA ST. E.C.4.

BIBBY COUPLINGS



THE WELLMAN BIBBY Co., Ltd.,
Parnell House, 25, Wilton Road, London, S.W.
Telephone: ABBEY 1194

DESIGNED FROM THE INSIDE OUT


Load-Bearing High Tenacity Rayon Cords, embedded in gum rubber, which dissipates heat and reduces internal friction to a minimum.
Controlled wedging action of volumetrically correct compression cushion ensures flexibility and high horse power transmission factor.
Tough outer covers of Rubber impregnated cotton duck, bias cut for greater flexibility, give maximum wear, resistance and grip.
Elastic rubber cushion distends when flexing over pulleys.

Made to B.S. 1440/1948

TURNERS
RAYON CORD V BELTS

TURNER BROTHERS ASBESTOS CO. LTD. ROCHDALE ENGLAND
A MEMBER OF THE TURNER & NEWALL ORGANISATION

McNEIL
manhole doors for air-receivers, boilers, etc.

HEAVY STEEL PRESSINGS
FOUNDRY LADLES
FABRICATED STEELWORK
WELDED CENTRAL HEATING BOILERS

CHARLES McNEIL LIMITED
KINNING PARK HYDRAULIC FORGE
570 SCOTLAND STREET, GLASGOW, S.1.
Grams: "McNeil, Glasgow" Phone: South 1131

We sell efficiency . . .

Efficiency has many faces, but whatever the job it is always a pleasure to recognise it. That is as it should be, for the personal factor will always be of decisive importance. But in this mechanised age efficiency increasingly depends on up-to-the-minute plant and machinery, designed to make or move your products more quickly, more cheaply.

What about your business? You know the latest equipment could cut your costs—you've been into it all before now—but you may be reluctant to tie up your working capital.

So have a word with us about the best way of financing it. You'll find the address of your nearest U.D.T. office in the local directory.

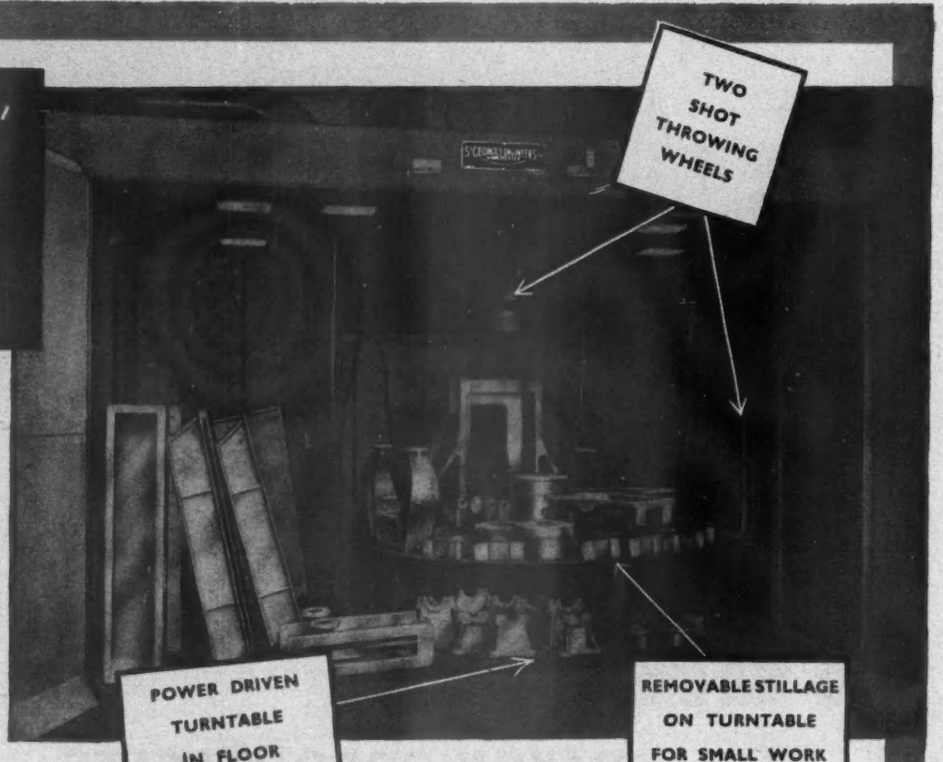
UNITED DOMINIONS TRUST LIMITED

UNITED DOMINIONS HOUSE, EASTCHEAP, LONDON, E.C.3
Over sixty branches throughout the United Kingdom and Eire

'UNIVERSAL' WHEEL BLAST ROOM PLANT
14'0" x 10'0" x 8'6"

comprising
TWO SHOT THROWING WHEELS WITH PRESSURE NOZZLE FOR SPECIAL WORK

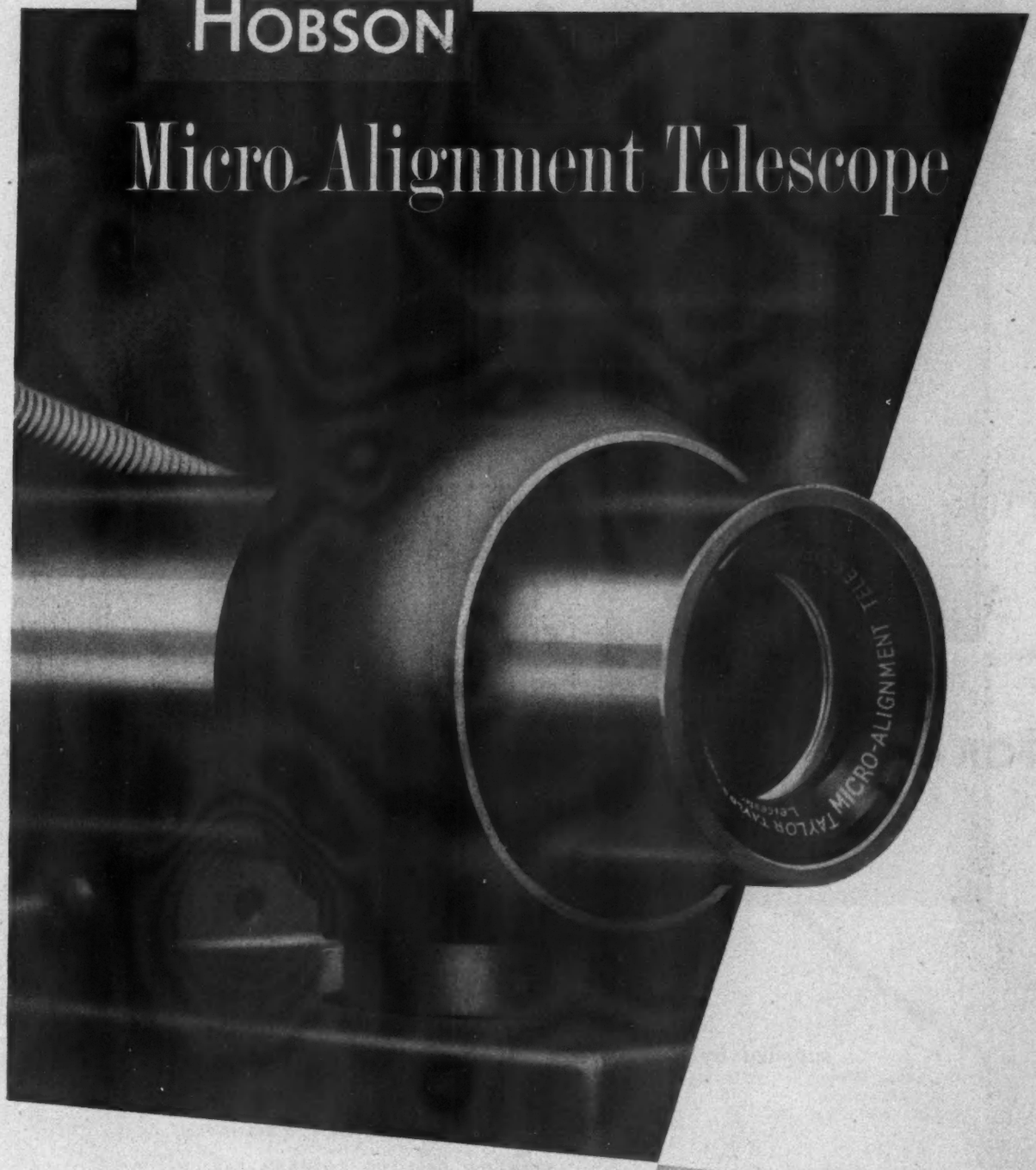
Made for **MESSRS. HEENAN AND FROUDE LTD. OF WORCESTER,** this plant is designed to accommodate all types of miscellaneous castings, welded fabricated work, and large steel tanks.



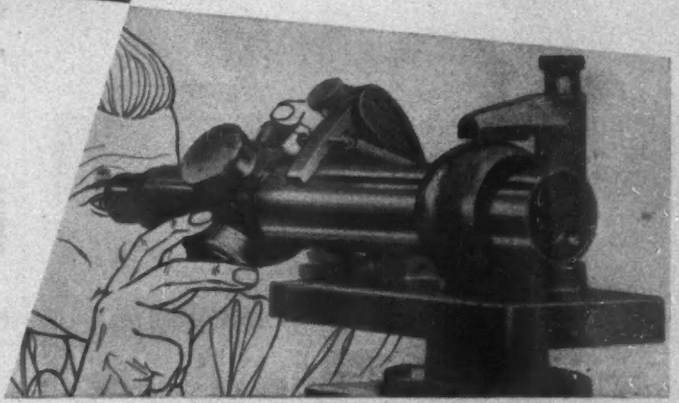
ST. GEORGES ENGINEERS LTD.
ORDSALL LANE, MANCHESTER 5
Telephone: TRAfford Park 1207 (4 lines). Telegrams: "Georgic" Manchester 5

TAYLOR-HOBSON

Micro-Alignment Telescope



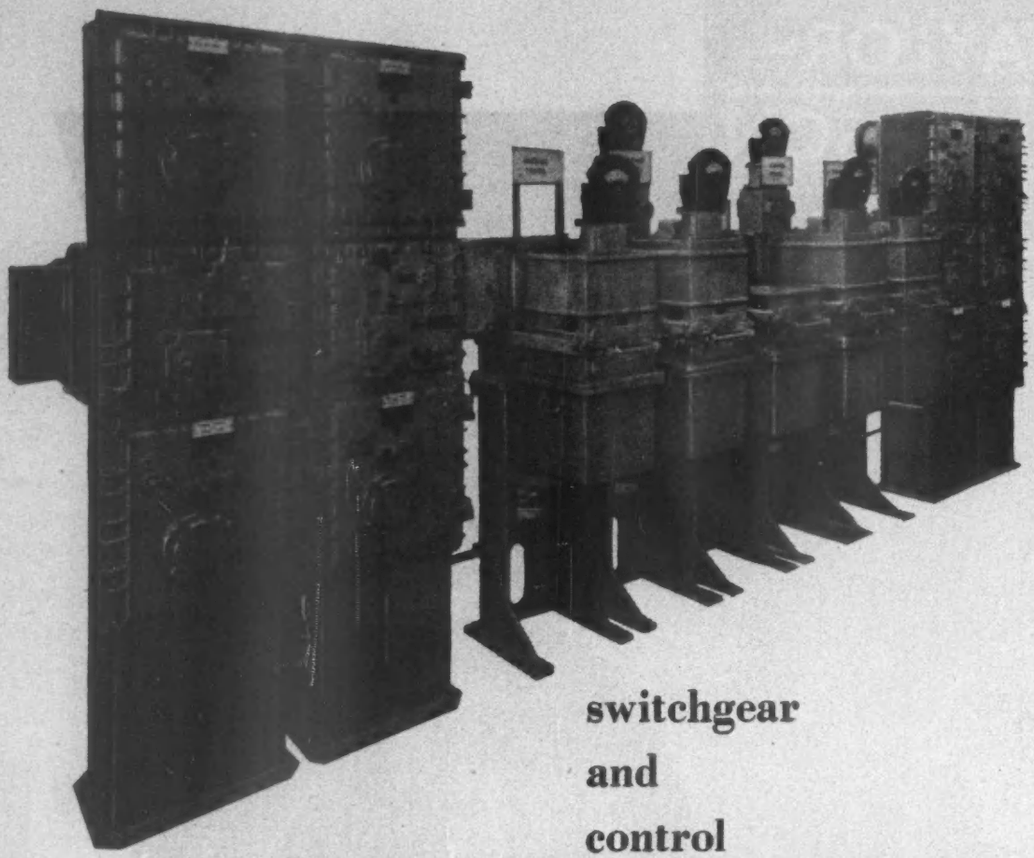
Set and check alignment, parallelism, squareness and generate plane surfaces of Diesel Engines, Turbines and Generators, Machine Tools, Aircraft Jigs, Nuclear Reactors by Optical Tooling.



A Division of
RANK PRECISION INDUSTRIES LTD.

TAYLOR TAYLOR & HOBSON LTD. LEICESTER ENGLAND

AT/18.



switchgear
and
control
equipment

FOR OILFIELD & REFINERY INSTALLATIONS

from
Generation
to
Distribution

supplied by Reyrolle at:

CORYTON, GRANGEMOUTH, ISLE OF GRAIN,
LLANDARCY, NORTHWICH, SHELLHAVEN,
STANLOW, GEELONG, KWINANA, SARNIA,
FRONTIGNAN, L'AVERA, SERIA, BOMBAY, VENICE,
CARDON, MARACAIBO, HAMBURG, PERNIS,
HAIFA, ABADAN, ADEN, IRAQ, and KUWAIT.

Reyrolle

A. REYROLLE & COMPANY LIMITED HEBBURN, COUNTY DURHAM, ENGLAND

P.&W.MACLELLAN, LTD

CLUTHA WORKS
35 MACLELLAN STREET
GLASGOW S.1

STEEL BRIDGES
STEEL FRAMED BUILDINGS
STEEL RAILWAY WAGONS
TANKS
ELECTRIC WELDING
HYDRAULIC PRESSINGS
FORGINGS AND DROP STAMPINGS
RAILWAY AND GENERAL ENGINEERING

Telephone:
IBROX 1135 (4 lines)

Telegrams:
"MACLELLAN GLASGOW"

NON-FERROUS CASTINGS?
SCC OFFER A COMPLETE
Service

TO THE ENGINEERING INDUSTRY

One of the best equipped non-ferrous foundries in Europe, Sandwell offer you :—

(1) MOST MODERN METHODS. Finest quality precision Sand Castings, Gravity Die-Castings, Shell Moulded Castings, and Pressure Die-Castings.
(2) WIDEST RANGE. Castings from a few ounces up to 2 tons in weight.
(3) COMPETITIVE PRICES.
(4) PROMPT DELIVERIES.
(5) FREE TECHNICAL ADVICE on all Castings problems.

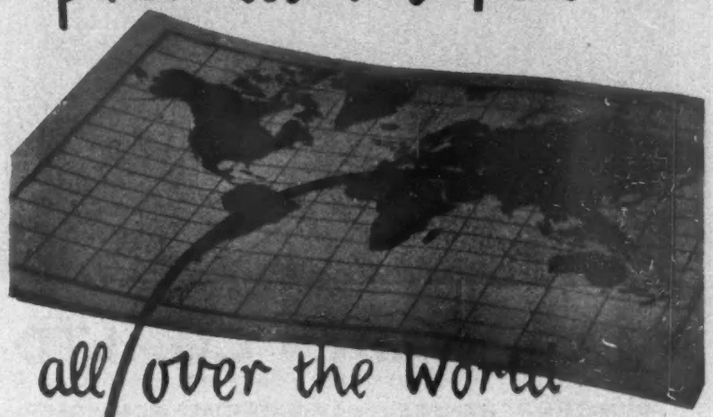
For all your requirements in non-ferrous castings, LET SANDWELL QUOTE.

ILLUSTRATED LITERATURE ON REQUEST.

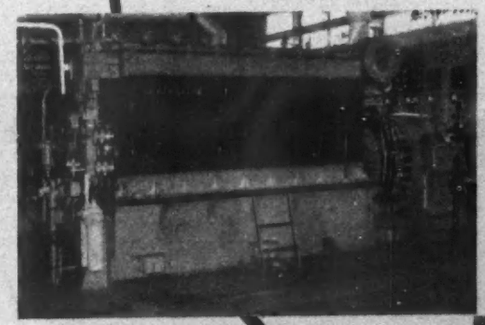
THE SANDWELL CASTING CO.
BANK STREET FOUNDRY, WEST BROMWICH.
Telephone: STOnecross 2231 (4 lines). Telegrams: "REPCAST", WEST BROMWICH.
One of the SANBRA Group of Companies

LISTER BLACKSTONE

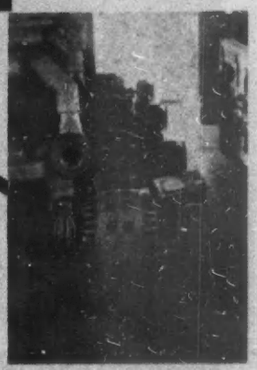
provides the power



all over the world



IN RABAUL,
New Britain, electricity is supplied by four 320 kW alternators, each powered by a Lister Blackstone EVS8 480 h.p. diesel engine.



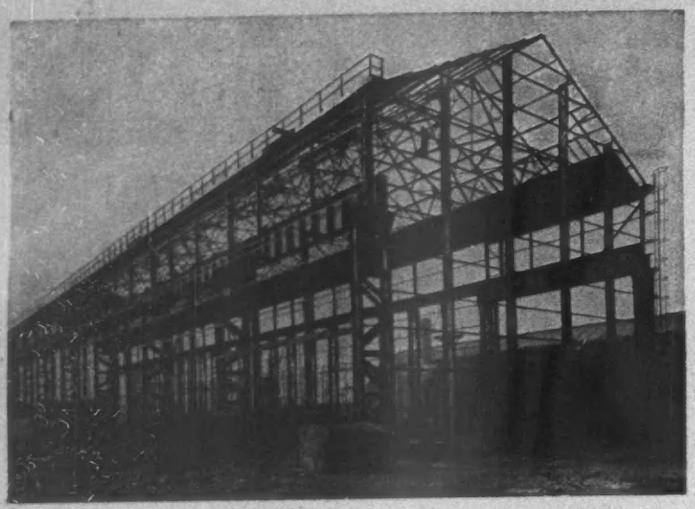
Photos by courtesy of the Commissioners of Australia Dept. of Works & Housing.

MEDIUM SPEED DIESEL ENGINES
FROM 3 TO 1320 B.H.P.

R. A. LISTER & CO. LIMITED
BLACKSTONE & CO. LIMITED

DURSLEY, GLOUCESTERSHIRE, ENGLAND
Phone: 2371 Telegrams & Cables: Blackstone, Dursley
London Office: Imperial House, Kingsway, W.C.2. Phone: TEMple Bar 9401

Structures in Steel



A. & J. MAIN & CO. LTD.

VINCENT HOUSE,
VINCENT SQUARE,
LONDON, S.W.1.

CLYDESDALE IRON WORKS,
POSSILPARK,
GLASGOW, N.2.

TELEGRAMS: KELVIN, SOWEST, LONDON
KELVIN, GLASGOW.

CALCUTTA · CHITTAGONG · NAIROBI

Here is the perfect jointing for high pressure smooth surface or screw unions!

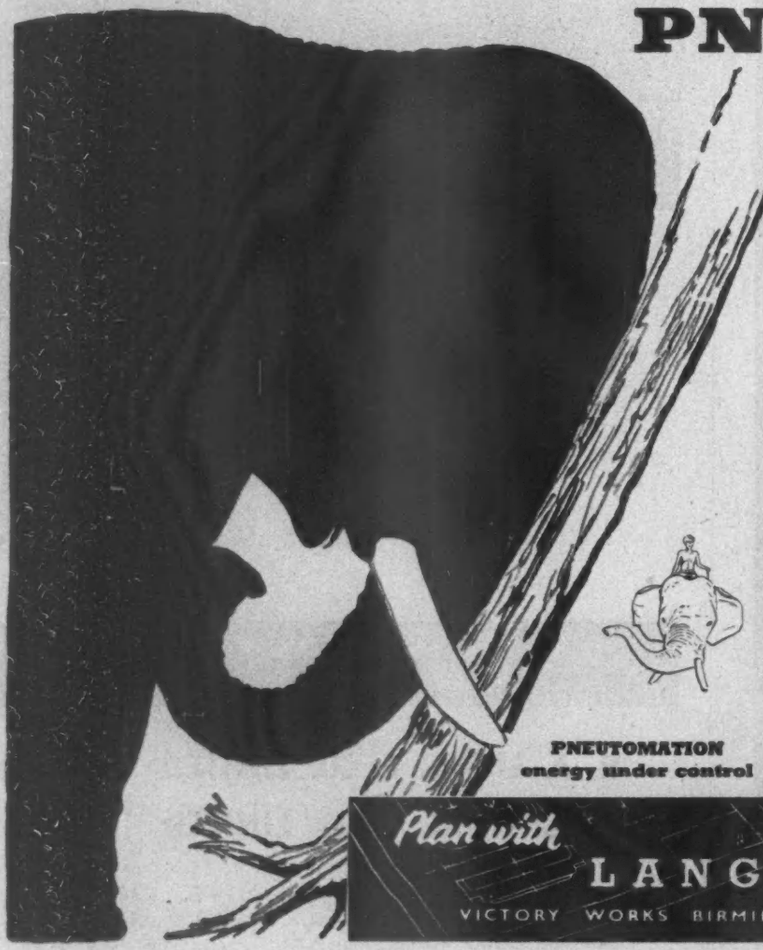
Tested and recommended by the Ministry of Supply (MTV Branch) Reference No. VG.6/300/FIR for export to tropical countries.

OSOTITE—the modern scientific sealing which has been proved by rigorous tests to be the perfect jointing for smooth surface and screw unions. OSOTITE is a simply applied liquid compound, impervious to heat, petrol, oil, grease, water and steam which ensure in a few minutes a HIGH PRESSURE GAS, AIR or WATER-TIGHT JOINT. Write for full details and prices.

OSOTITE **A SLICK PRODUCT**

SLICK-BRANDS LIMITED
WADDON CROYDON

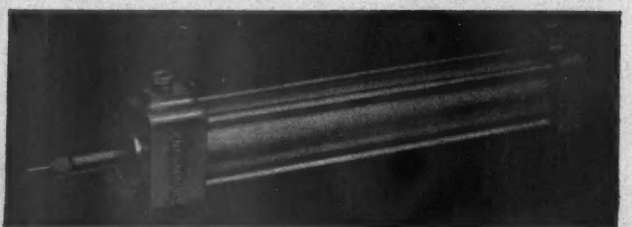
PNEUTOMATION



power in the right direction

A push to production with the power of an elephant—that's PNEUTOMATION! Strong, steady power under perfect control, in the right place at the right time. The power to do anything from bell-ringing to jig-boring—and do it faster, at less cost. A wide range of standard equipment makes the system adaptable for any layout, any space. Simplicity of design, careful workmanship and completely non-corrodible materials cut replacement and maintenance costs, ensures that Lang PNEUTOMATION is a really long-lasting trouble-free pneumatic power system.

Pneutomation never forgets to operate



The 'Pneulang' basic cylinder unit, just one of the 284 cylinders available 'off-the-shelf'. The range of **PNEUTOMATION** equipment also includes many types of manual and automatic valves, lubricators, air flow regulators, pipes and fittings, etc.

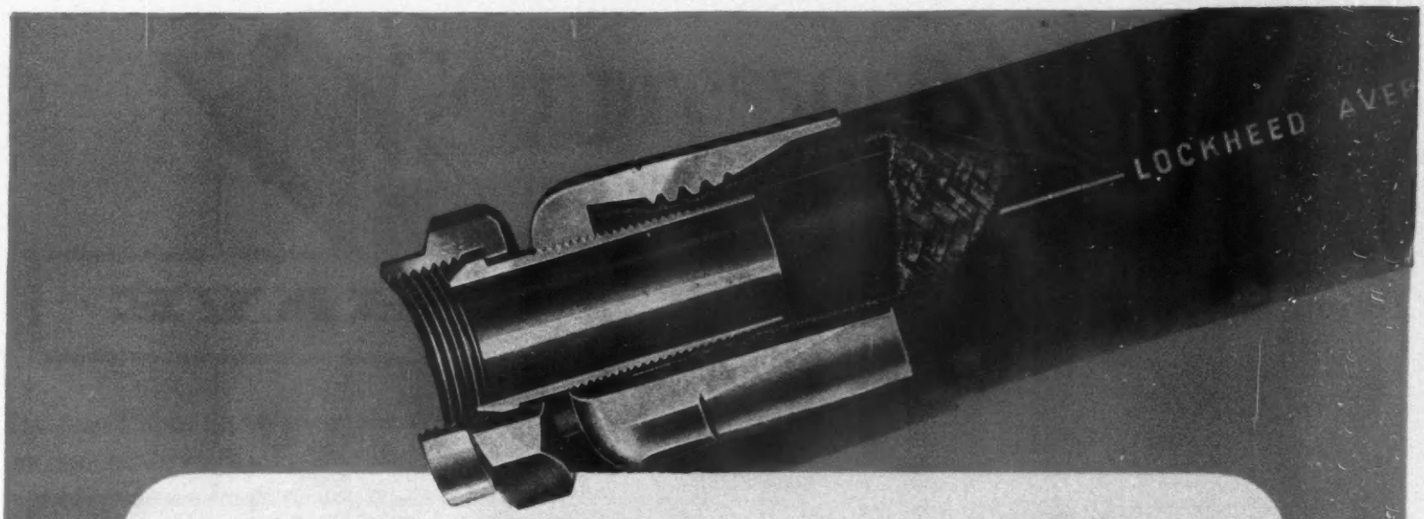
PNEUTOMATION
energy under control

Plan with

LANG PNEUMATIC LTD

VICTORY WORKS BIRMINGHAM ROAD WOLVERHAMPTON Tel 25221-2-3

P1652



New HIGH PRESSURE HOSES

Following the success of their hoses, Lockheed-Avery announce a new range, available with single and double wire braid, with a number of important features.

These hoses are backed by more than 20 years of experience in a wide range of industrial and aircraft hose applications, often in conjunction with other equipment made by the AP group.

The hoses are suitable for pressures ranging from 300-lbs. per sq. in. for 2″ bore hose to 4050-lbs. per sq. in. for $\frac{1}{8}$″ bore hose.

End-fittings are of steel, with hexagonal sleeves which expedite fitting, and are re-usable.

When desired, swaged-on end-fittings can be supplied for hoses up to $\frac{3}{8}$″ bore.

90° elbows and 45° bends are available.

FOUR DIFFERENT LININGS

These new hoses types 77-99 have the advantage that they can be supplied with any one of these four linings:

NITRILE : NATURAL RUBBER : BUTYL : NEOPRENE

A list of compounds, with the lining recommended, can be supplied on request. The longest length of hose obtainable remains at approximately 30 ft. for hoses of $\frac{3}{8}$″ bore and over, and approximately 15 ft. for hoses of $\frac{1}{4}$″ and $\frac{1}{2}$″ bore. Within these limits any desired length of hose assembly can be supplied.

FEATURES

Re-usable steel end fittings for strength and convenience

Hexagon sleeves for ease of assembly

Cadmium plated for corrosion resistance

Choice of four linings

Elbows and bends available

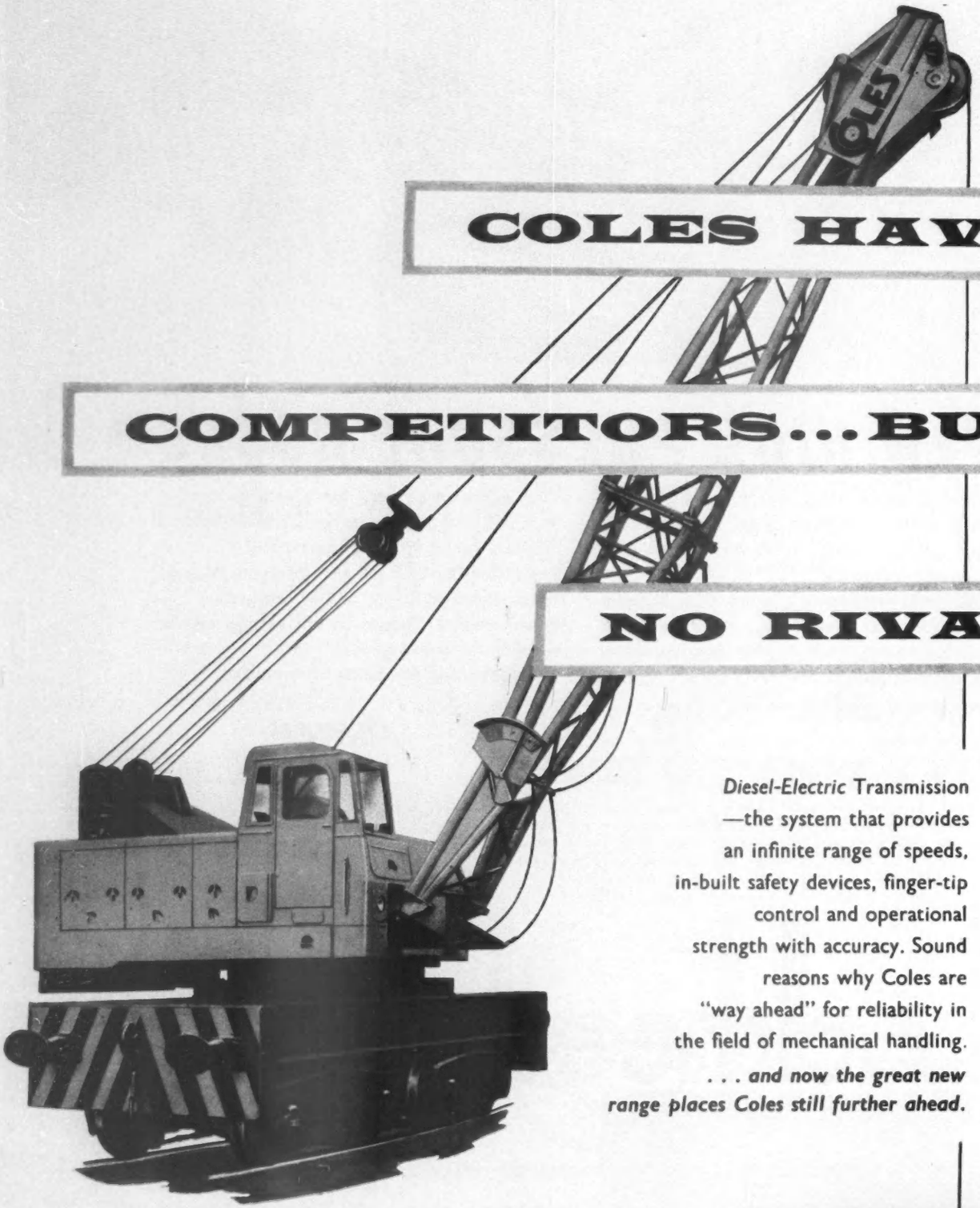
Wire braiding gives great safety.

Lockheed Avery

Regd. Trade Mark: Lockheed

AUTOMOTIVE PRODUCTS COMPANY LTD., LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

E



COLES HAVE

COMPETITORS...BUT

NO RIVAL

Diesel-Electric Transmission —the system that provides an infinite range of speeds, in-built safety devices, finger-tip control and operational strength with accuracy. Sound reasons why Coles are "way ahead" for reliability in the field of mechanical handling.

. . . and now the great new range places Coles still further ahead.

THE NAME THAT CARRIES WEIGHT

COLES

Designed, manufactured and marketed by:-

STEELS ENGINEERING PRODUCTS LIMITED

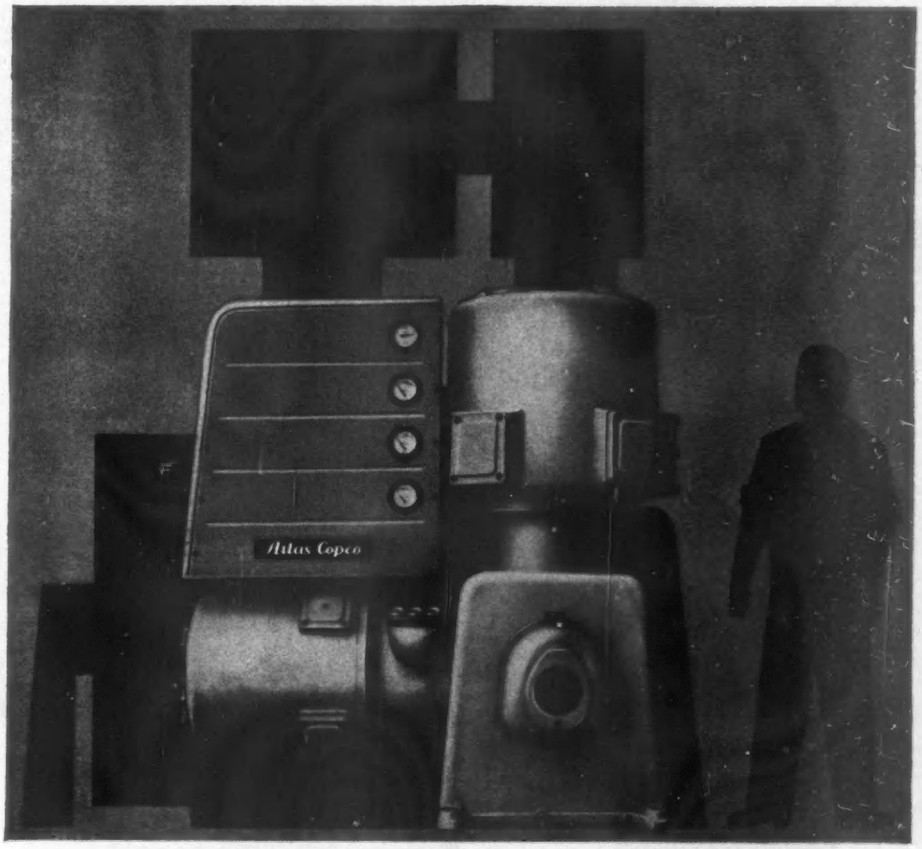
Sunderland, England Tel: 56281 (10 lines) Grams: Steel, Sunderland

SALES AND SERVICE : Glasgow : 235 Bath St., C.2 · **Newcastle** : Worswick Chambers, Worswick St., 1
London : 143 Sloane Street, S.W.1 · **Manchester** : 153 Oxford Road, 13 · **Birmingham** : 39 Thorp Street, 5

New Compressor Design

GIVES OUTSTANDING SPACE SAVING WITH REDUCED RUNNING COSTS

The Atlas Copco ER6 is a new stationary compressor which uses fundamental improvements in design to achieve remarkable results in performance and efficiency. The illustration shows the size of the ER6 compared with a conventional compressor of similar output: yet this extraordinary saving in space is achieved with *added* efficiency and economy, and with the same reliability of operation, which has characterised Atlas Copco compressors for 50 years.



Economy of operation

The specific power consumption for the ER6 is 10-15% lower than for most machines of this size on the market. At 4,000 hours running time per year this means an *annual power saving of up to* £360.

In addition the cooling water consumption of the ER6 is very low because of the special design of the intercooler, amounting to only 440 gallons per hour at 60°F. This is less than half the quantity needed for the majority of other similar air compressors.

Economy of installation

The ER6 requires an exceptionally small amount of floor space for its capacity. This reduces the cost of foundation and erection, especially with the use of a flange-mounted motor.

Erection and alignment can be simplified by using a base frame which can be delivered as extra equipment. The balance is so good that the ER6 can be mounted on a skid frame, which does not require a concrete foundation. Skid frame mounting is especially advantageous for contractors and makes it possible for the compressors to be moved easily and at low cost from one site to another.

The ER6 is equipped with an oil pressure control device and cooling water gauges together with a full set of instruments for visual control.

PRINCIPAL DATA

Maximum pressure in psi	Speed in rpm	Low-pressure piston displacement in cfm	Free air delivered at 100 psi in cfm	Cooling water required at 60°F approx in galls/hour	Weight in pounds
125	485	1,303	1,075	440	6,600

A complete range of compressed air equipment

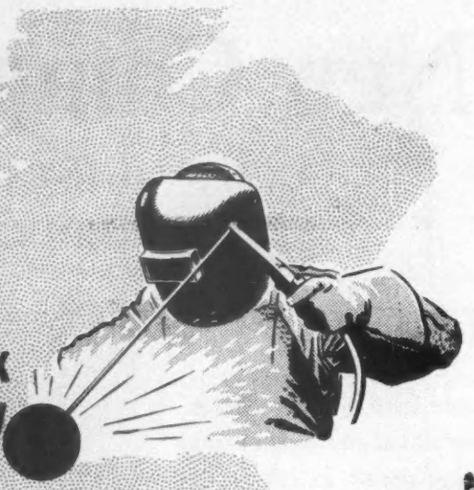
Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco (Great Britain) Ltd., Beresford Ave., Wembley, Middx. or Atlas Copco AB, Stockholm 1, Sweden

On-the-Spot Service FOR all CUSTOMERS

RECONDITIONING OF ALL TYPES OF PLANT EQUIPMENT



By Appointment to H.M. The Queen Agricultural Engineers

P.W. Dilloway LIMITED

and now DEVON

WE COLLECT AND DELIVER

P. W. DILLOWAY LIMITED

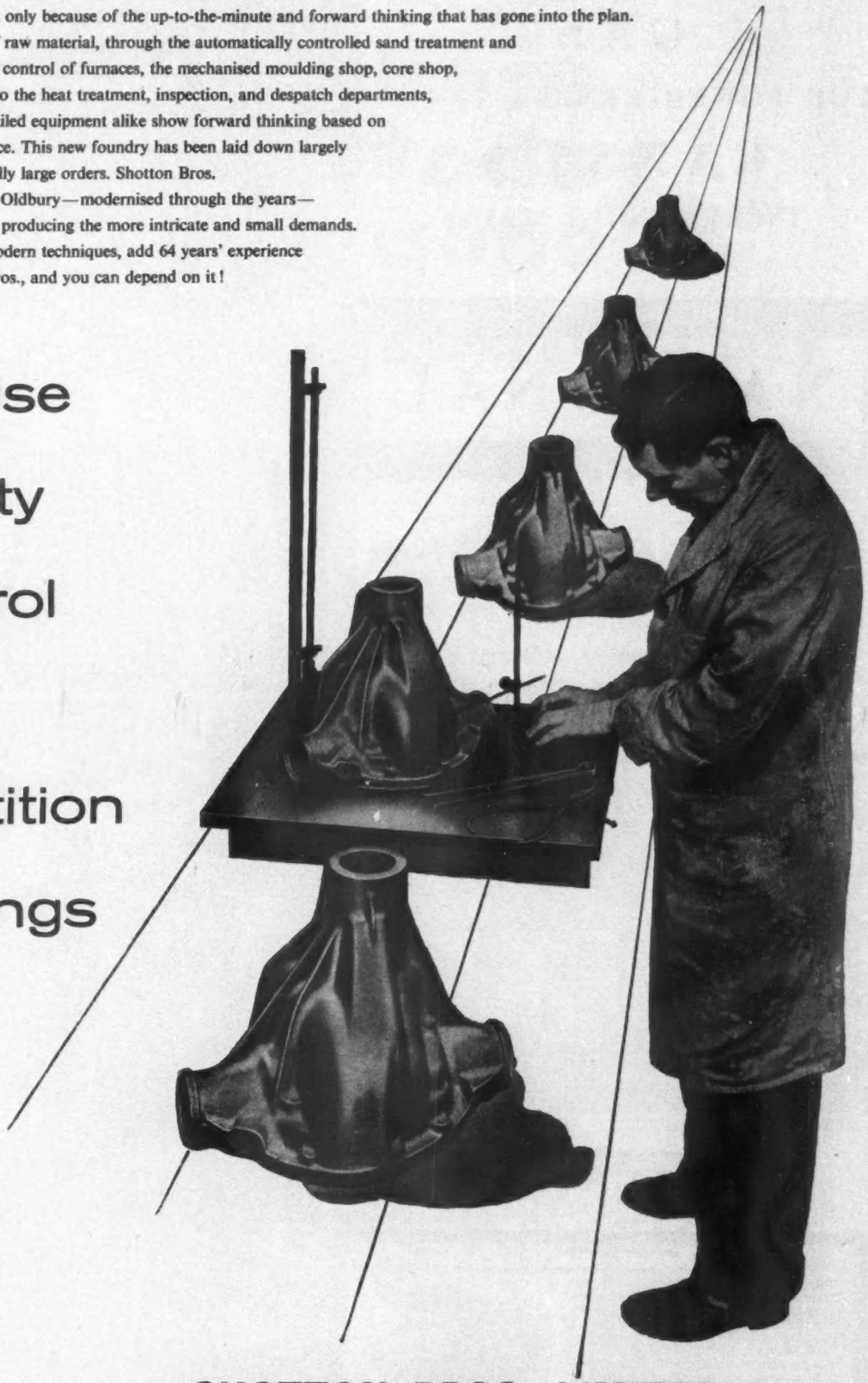
HEAD OFFICE AND WORKS: SOUTHALL, MIDDLESEX Telephone: SOUTHALL 6511

SCOTTISH OFFICE AND WORKS: 32 BURNFIELD ROAD, GIFFNOCK, GLASGOW Telephone: GIFFNOCK 1125 6

WEST COUNTRY OFFICE AND WORKS: TEIGNMOUTH, DEVON Telephone: TEIGNMOUTH 1325

One of the most modern foundries in the world is the new Shotton Bros. foundry at Halesowen. It is "modern" not only because of the up-to-the-minute and forward thinking that has gone into the plan. From the intake of raw material, through the automatically controlled sand treatment and handling plant, the control of furnaces, the mechanised moulding shop, core shop, and pattern shop, to the heat treatment, inspection, and despatch departments, the layout and detailed equipment alike show forward thinking based on unrivalled experience. This new foundry has been laid down largely to handle numerically large orders. Shotton Bros. original foundry at Oldbury—modernised through the years—will concentrate on producing the more intricate and small demands. Take the best of modern techniques, add 64 years' experience —that's Shotton Bros., and you can depend on it!

precise quality control of repetition castings



BLACKHEART MALLEABLE IRON CASTINGS

SHOTTON BROS. LIMITED

MANCHESTER STREET FOUNDRY

OLDBURY · BIRMINGHAM · Phone: Broadwell 1631

MEMBER OF THE BIRFIELD GROUP

This company participates in the research, technical, and productive resources of the Birfield Group, which includes Hardy Spicer Ltd., Laycock Engineering Ltd., Kent Alloys Ltd., Forgings and Presswork Ltd., and many other famous firms

F

GAS

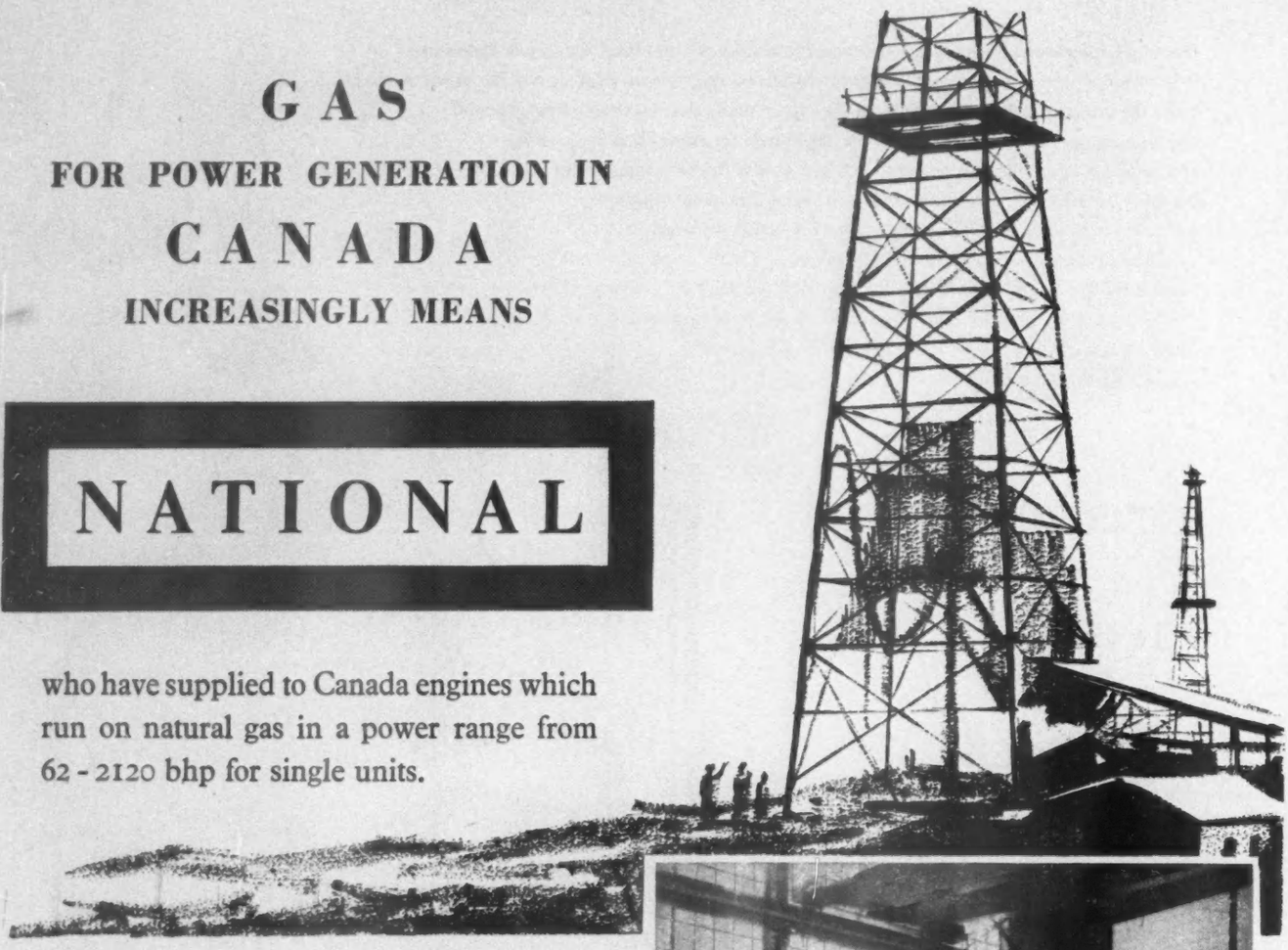
FOR POWER GENERATION IN

CANADA

INCREASINGLY MEANS

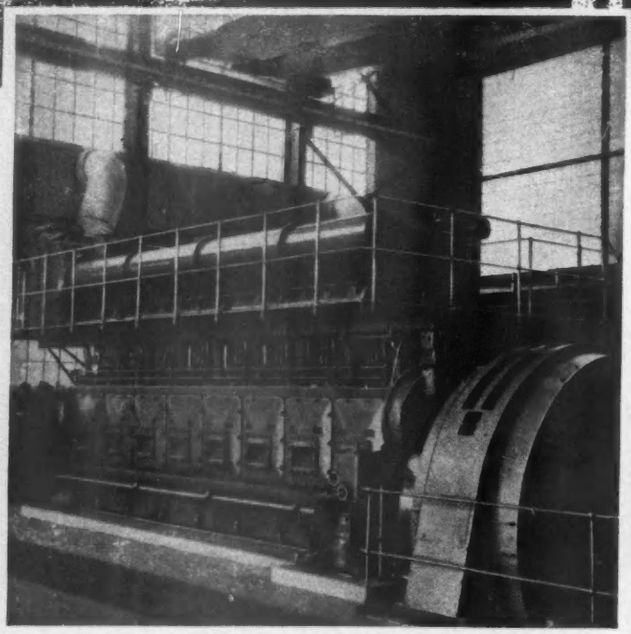
NATIONAL

who have supplied to Canada engines which run on natural gas in a power range from 62 - 2120 bhp for single units.



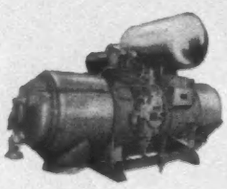
In a similar range of powers are National dual-fuel or alternative fuel units, using light or heavy fuel oils, together with sewage, natural or town's gas.

Expert technical staff are at your service and complete installation specifications are available on request.



One of two 1,200 kW natural gas engines at Swift Current, Saskatchewan, Canada

FREE PISTON GASIFYERS — We also manufacture Free Piston Gasifyers under licence from Alan Muntz and Co. Ltd., Pescara and S.E.P. Gasifyers, with a suitable Gas Turbine, provide power in single and multiple units from 1,000 to 20,000 h.p. for electrical generating sets, marine propulsion, locomotive traction and compressor and pumping sets.
Please ask for leaflet No 1801

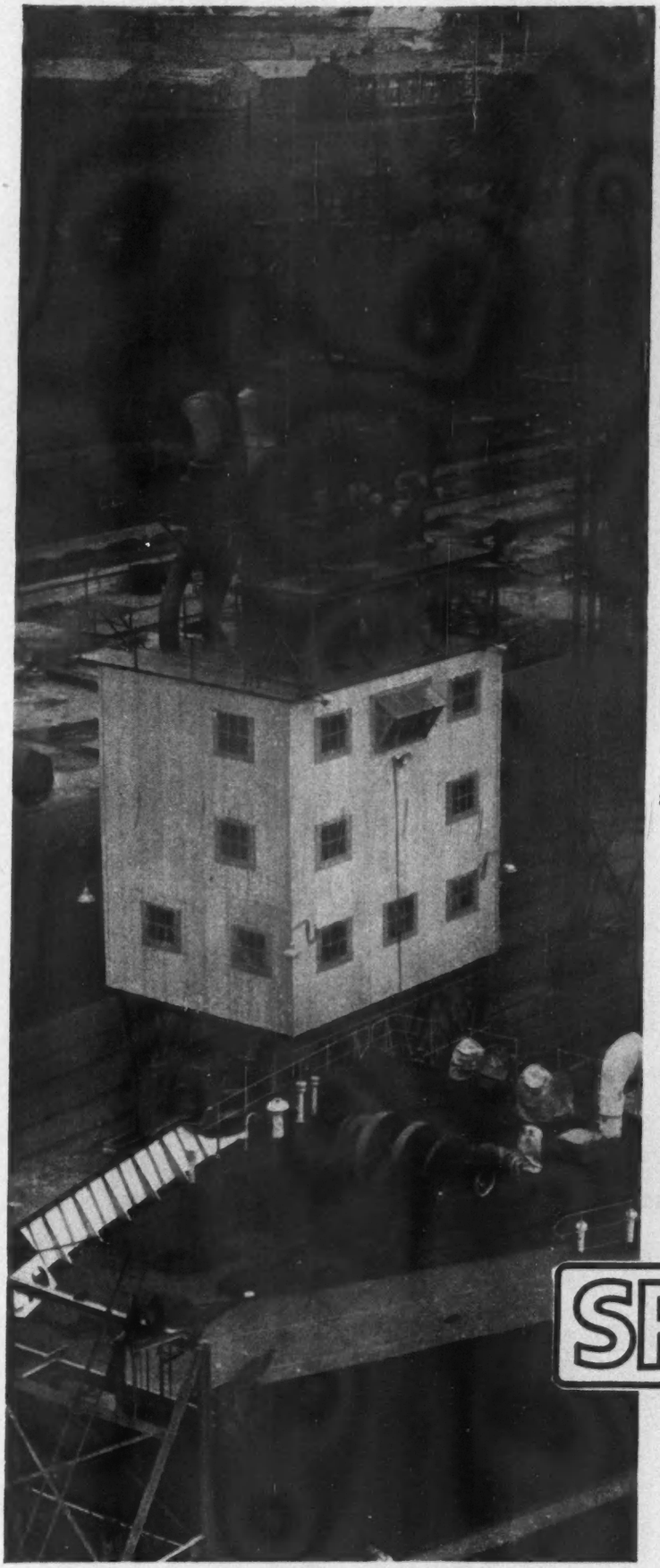


A member of the Hawker Siddeley Group

THE NATIONAL GAS AND OIL ENGINE CO. LTD., ASHTON-UNDER-LYNE, LANCASHIRE

Sole Export Sales Concessionaires: BRUSH INTERNATIONAL LTD., National Works, Ashton-under-Lyne, England.

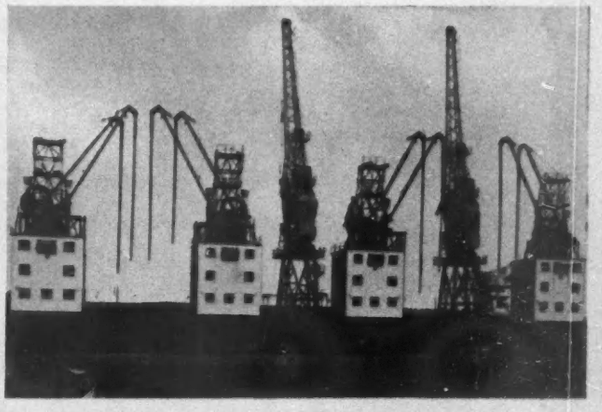
NAT 38



here today gone tomorrow

thanks to SPENCER

Spencer Pneumatic Elevators are playing a vital part in the speedy turn round of ships in ports, unloading grain cargoes at rates up to 600 tons per hour.



SPENCER

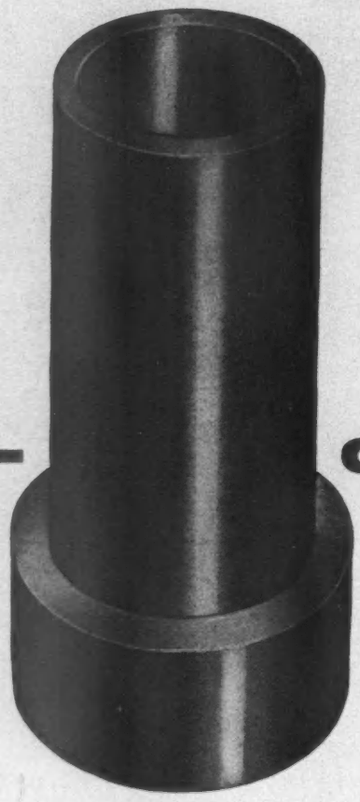
PNEUMATIC ELEVATORS

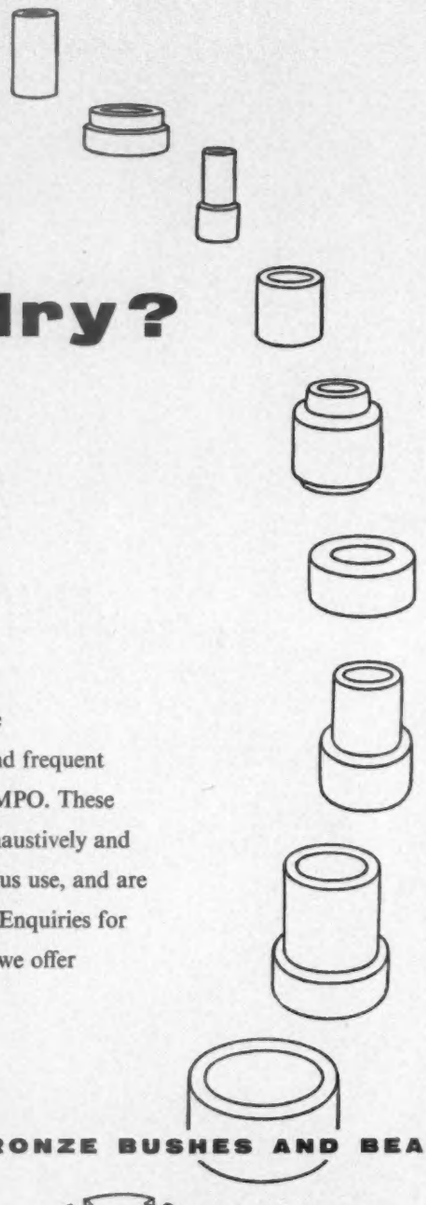
SPENCER (MELKSHAM) LTD.
MELKSHAM · WILTSHIRE

BRANCH OFFICES:

Ingersoll House, 9 Kingsway, London, W.C.2. Tel. Covent Garden 1800 · 34 Castle Street, Liverpool, 2. Tel. CENtral 3738

SWEET- or dry?

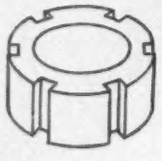


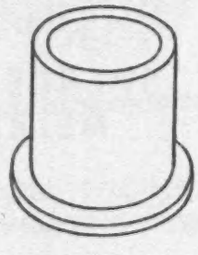


The choice of bearings—whether they will operate sweetly, or run dry, in locations where constant and frequent attention is impossible—has a ready answer: COMPO. These oil-retaining sintered metal bearings have been exhaustively and thoroughly proved reliable through years of arduous use, and are available in a comprehensive range of stock sizes. Enquiries for special COMPO bearings are also welcomed, and we offer consultative technical advice on matters of design.

COMPO

OIL-RETAINING BRONZE BUSHES AND BEARINGS





Bound Brook Bearings Limited

Trent Valley Road, Lichfield, Staffs.
Telephone: Lichfield 2027/8

MEMBER OF THE BIRFIELD GROUP

FOUNDATIONS

Economies made possible with CUSHYFOOT MOUNTINGS

Metalastik Cushyfoot mountings have proved outstandingly successful in their effective isolation of shocks and vibration arising from all types and size of machines.

If Metalastik Cushyfoot mountings are used, many machines can be mounted on lighter foundations, just enough to support the dead load without consideration of dynamic forces.

In many cases the large 'inertia' blocks of concrete, so often used, can be dispensed with, or greatly reduced in mass.

'A' AND 'B' SERIES

For loads of 200-3,500 lb. per mounting with deflections up to ¼", Cushyfoot mountings provide different degrees of flexibility according to the direction of the load but can be disposed to give the same resilience in all directions.

HIGH DEFLECTION SERIES

With characteristics similar to 'A' and 'B' types but double the deflection, this series is especially suitable for machines in the lower speed range. Deflections up to 1" can be obtained by fitting two mountings, one above the other.

FRICTIONAL LOCATION

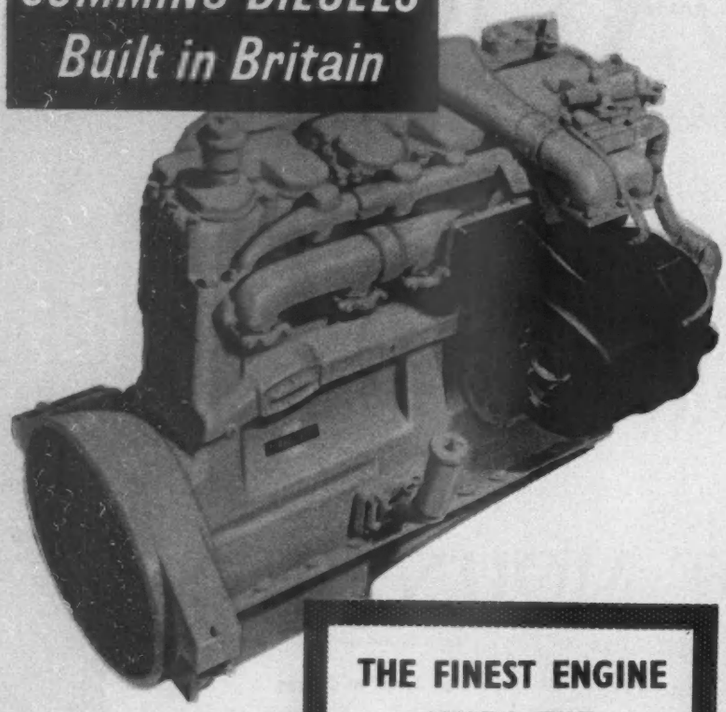
Cushyfoot mountings can be supplied with frictional locating pads which obviate bolting down.

Full particulars of Cushyfoot mountings on application.

METALASTIK

METALASTIK LTD., LEICESTER

CUMMINS* DIESELS
Built in Britain



THE FINEST ENGINE WITH THE FINEST SERVICE

CUMMINS DIESEL SALES & SERVICE LTD. operate a nation-wide servicing scheme to keep British and American-built CUMMINS engines in peak condition always. Unrivalled facilities exist for rebuilding to maker's standards, together with a speedy field service covering all repairs from minor adjustments to replacement with new or service-exchange units.

CUMMINS diesel engines are made in Great Britain, range from 150-335 B.H.P.

CUMMINS gives you the BIG plus MORE PROFIT

CUMMINS DIESEL SALES & SERVICE LTD

25 BERKELEY SQUARE, LONDON, W.1

Telephone: MAYfair 9090

SPARES AND SERVICE:
HUNSBURY WORKS, NORTHAMPTON
Telephone: Northampton 5262

* *Trade Mark of Cummins Engine Company, Inc.*

Roll Cladding

For Rolls, Shafts Tubes and Drums

Rosedowns undertake the external cladding of cylindrical bodies with stainless steel by a new and patented process.

The perfect contact between cladding and foundation body ensures the highest possible heat transfer which makes the process particularly suitable for heated or cooled rolls or drums.

The services provided at Hull include the manufacture of complete clad rolls, etc. from 4 to 42 inches in diameter, machined and polished to specification, or alternatively, the application of the cladding process to customers' own rolls, shafts, etc.

ROSEDOWNS

ROSE, DOWNS & THOMPSON LTD

Old Foundry, Hull · Telephone: 29864

London Office: 39 Victoria Street, S.W.1 · Tel: ABBey 2496

MEMBER OF THE POWER-GAS GROUP

High Efficiency Machining

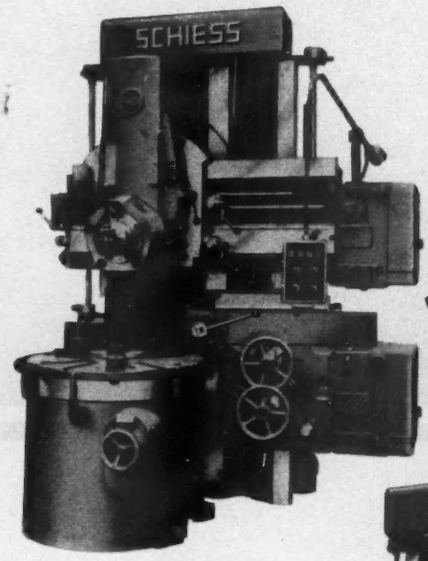
through the **very wide speed ranges**

and **high table speeds**

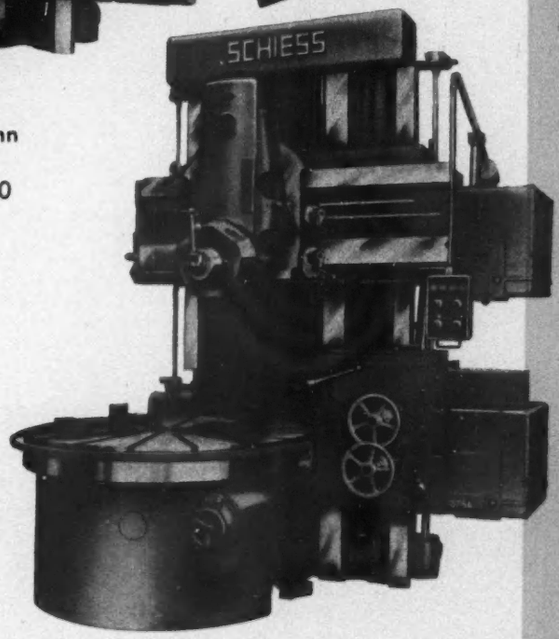
which enable the optimum cutting speed to be selected always whether carbide or high speed tools are used.

For Example – Single Column Boring Mill Models KE

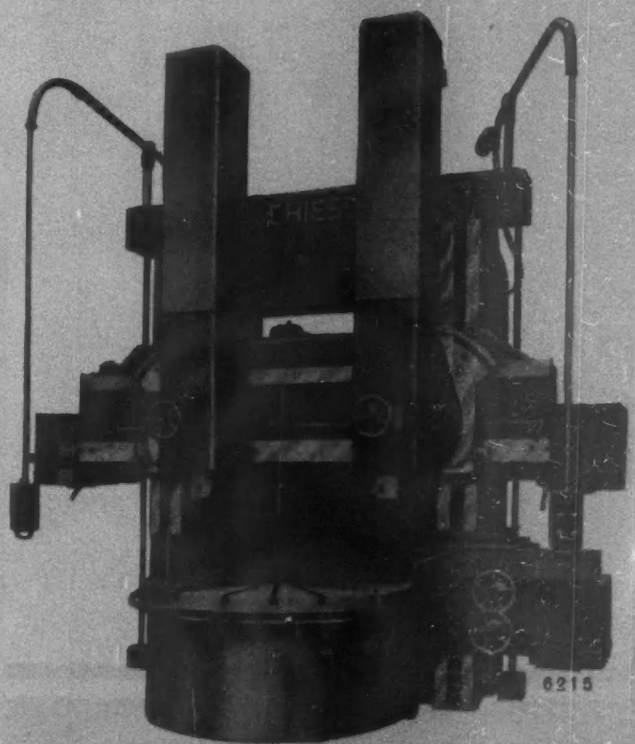
Specification			
Type	KE 100	KE 125	KE 160
Max. Turning Diameter / Table Diameter ins.			
Max. Turning Diam. with Side H...			
		16"	16"
Table r.p.m.	6.2 310	4.7 237	3.8 191
...ber of Horizontal and Vertical Feeds	12	12	12
Range of Feeds per Revolution of Table ins.	.0026 – 26	.0026 – 26	.0026 – 26



Single Column Boring Mill Model KE 100



Single Column Boring Mill Model KE 160



Double Column Boring Mill Model KZ 200

SCHIESS AKTIENGESELLSCHAFT DÜSSELDORF (GERMANY)

Sole Agents United Kingdom and Eire:- **BURTON, GRIFFITHS & CO. LTD. BIRMINGHAM**

The lower illustration shows the 1000 ft. walk-way through columns designed to provide a clear and uninterrupted passage for gangways and services.

At Lackenby Steelworks

The illustration shows one of the control panels in this, the most modern open-hearth steel plant in the kingdom, built by Dorman Long for Dorman Long.

It supplies ingots to the new Universal Beam Mill.

The heavy crane girder, top right, is 125 ft. span.

DORMAN LONG

Dorman Long (Steel) Ltd. Dorman Long (Bridge & Engineering) Ltd.

The Power of the Atom

To nuclear power generation Simon-Carves bring immense experience of major plant construction and civil engineering for the fuel, electricity and heavy chemical industries, including the building of orthodox steam power stations for more than thirty years.

In the building of nuclear power stations Simon-Carves assume responsibility for all civil engineering and reinforced concrete design and construction, including nuclear reactor structures and biological shielding, and for complete heat-exchange steam-generating plant and water treatment systems.

Simon-Carves are conducting continuous research, both in their own laboratories at Cheadle Heath and jointly with The General Electric Company at Erith, on the improvement of steam conditions resulting from improved reactor outputs, on the use of pre-stressed concrete in reactor structures and elsewhere, and on the safe disposal of radio-active waste.

This work is playing an important part in the development of future advanced designs and in the reduction of cost per kilowatt.

Simon-Carves Ltd

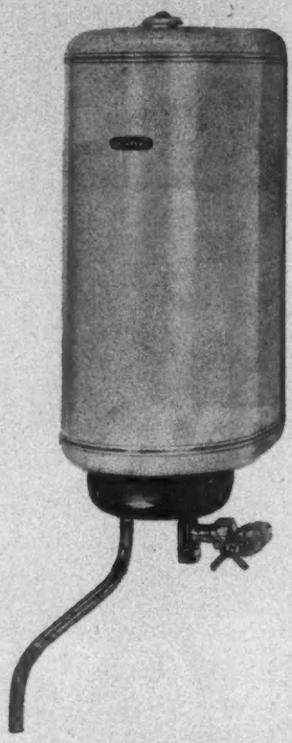
SIMON ENGINEERING GROUP

NUCLEAR POWER DIVISION / Cheadle Heath, Stockport

IN ASSOCIATION WITH THE GENERAL ELECTRIC CO LTD · THE MOTHERWELL BRIDGE & ENGINEERING CO LTD · JOHN MOWLEM & CO LTD

SC177(A)/PS

Heatrae of Norwich



The Heatrae LIDO made in three sizes:
1½, 2·2 and 3 gallons capacity for domestic use.
The perfect automatically controlled Electric Water Heater

Ask for leaflet No. 85.

A full range of larger sizes also available in non-pressure, pressure and cistern type for wall or floor mounting.

Established in 1920

HEATRAE LIMITED · NORWICH · ENGLAND

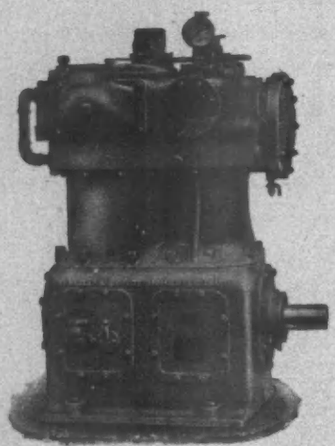
Telephone: NORWICH 25131 (Private Exchange) Telegrams: HEATRAE · NORWICH

Manufacturers of Electric Water Heaters, Oil Heaters, Immersion Heaters, Urns, Towel Rails, Airing Cupboard Heaters, Electric Fires, Flameproof Heating Apparatus, Food Trolley Warming Plates, Air Heaters and Steam Heated Oil Heaters.

AIR COMPRESSORS

VERTICAL SINGLE-ACTING TYPE

SINGLE STAGE.	100 LB. PER SQ. IN.	1 TO 155 CU. FT. PER MIN.
	60 LB. PER SQ. IN.	1 TO 380 CU. FT. PER MIN.
TWO STAGE.	100 LB. PER SQ. IN.	200 TO 310 CU. FT. PER MIN.



FOR PARTICULARS OF THESE COMPRESSORS AND FOR OTHER TYPES AND SIZES.
TELEPHONE: IPSWICH 56124 (3 LINES)
TELEGRAPH: "REAVELL, IPSWICH" OR WRITE TO:—

REAVELL & CO., LTD.
IPSWICH - ENGLAND

SPURS
BEVELS
WORM WHEELS
HELICALS
CHAIN GEARS

WORMS
RACKS
SCREWS
SILENT GEARS
CHANGE GEARS

Complete Supply
Cutting only

All materials standard pitches to 7ft diameter

General machine castings made to customers' patterns. Low prices for planing, boring, turning, screwcutting
Send your enquiries to

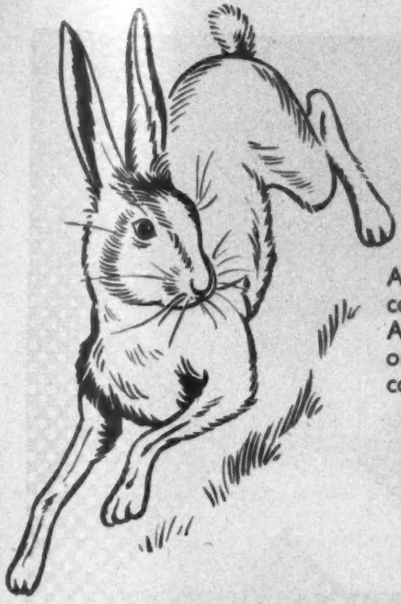
GREENWOOD'S STANDARD GEAR CUTTING CO. LTD.,
New Bond Street, Halifax. *Telephone: Halifax 52178* *Telegrams: "Gears."*

The Nitriding Process for Case-hardening Special Steels by Nitrogen offers

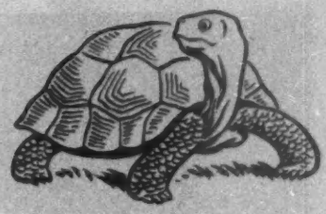
- Surface hardness up to 1100 D.P.H.
- Retention of full hardness after heating to 500°C.
- Maximum resistance to frictional wear and fatigue.
- Improved resistance to corrosion by water and steam.

Particulars from:—

NITRALLOY LIMITED
ATLAS WORKS SHEFFIELD, 4.
Telephone: Sheffield 26646. Telegrams: "NITRALLOY, SHEFFIELD."



For VARIABLE SPEED PROBLEMS



As an economical solution to any variable speed problem—one of the SADIVAR standard combinations—such as that illustrated below offers a number of major advantages. A seven to one speed range is obtained at any speed level by incorporating to the Sadivar one or more mass produced high efficiency planetary gears whose torque characteristics correspond to that of the machine to be motorised.

***Any reduced speed desirable within range of* 7 : 1**

the SADIVAR
STANDARD COMBINATIONS

SPEED STABILITY — IMMEDIATE DELIVERY

Agents in the Commonwealth and in 30 countries throughout the world.

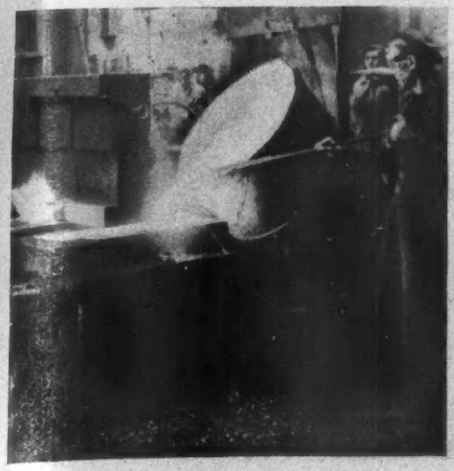
SADI ENGINEERING CO. LTD.

10-14 ANSDELL STREET · KENSINGTON SQUARE · LONDON, W.8

Telephone: Western 7653 *Cables:* SADIUNIT, LONDON

CASTINGS

prompt deliveries guaranteed



Owing to improved production facilities we are now in a position to offer prompt deliveries of the following types of grey iron castings:—

JOLTER AND SAND-SLINGER
Max. jolting weight, 3 tons. Max. box size, 6'x6'
Max. weight per casting, 10 to 30 cwt. approx.

FLOOR MOULDING
Capacity is available for all types of floor moulding including large cylinders, pipes and general jobbing work. Max. weight 3 tons approx.

HOLMES — FOUNDED 1850 — HUDDERSFIELD

All enquiries will be given immediate attention.

W. C. HOLMES & CO. LTD.
HUDDERSFIELD, LONDON, BIRMINGHAM

Telephones: Huddersfield 5280.
Birmingham: Midland 6830 London: Victoria 9971

ALUX

The most powerful name in corrosion control

We are proud to introduce a revolutionary aluminium finishing process which will be of vital interest to a large number of industries.

Briefly, ALUX provides a glass-hard, non-corrosive surface in any colour or texture.

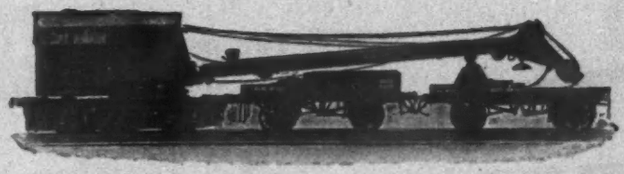
One application is for light or heat reflectors. ALUX gives a higher reflectivity percentage than any conventional material with a maintained efficiency in spite of thermal and corrosive attack.

We shall be glad to receive inquiries from manufacturers and advise them on the use of the ALUX process in any type of product where its unique properties would be of value.

VERITYS LIMITED · ESTABLISHED 1819
BRETTENHAM HOUSE, STRAND, W.C.2

and at BIRMINGHAM · BRISTOL · GLASGOW · MANCHESTER and NEWCASTLE-ON-TYNE

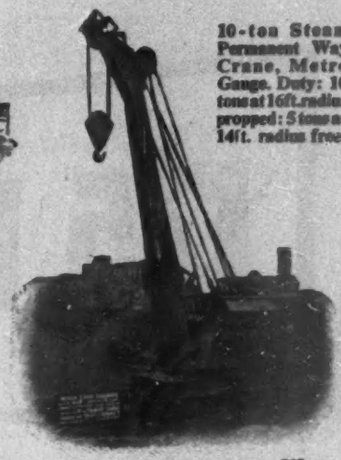
T&H FOR CRANES



10-ton Diesel Permanent Way Shunting Crane in train formation.

4-TON DIESEL SHUNTING CRANE, permanent way pattern, supplied to British Railways.

STEAM ELECTRIC DIESEL
DIESEL-ELECTRIC CRANES

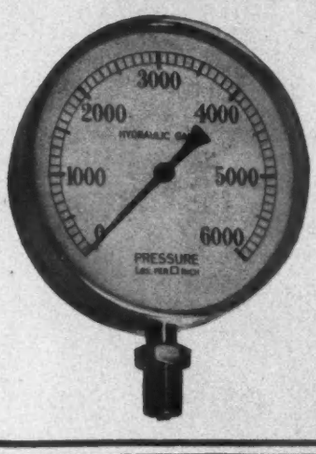


10-ton Steam Permanent Way Crane, Metre Gauge. Duty: 10 tons at 16ft. radius propped: 5 tons at 14ft. radius free.

TAYLOR & HUBBARD LTD. LEICESTER

Telegraphic Address: "Lifting, Leicester" Telephone Nos.: 22575–6

P37



PRESSURE GAUGES . .

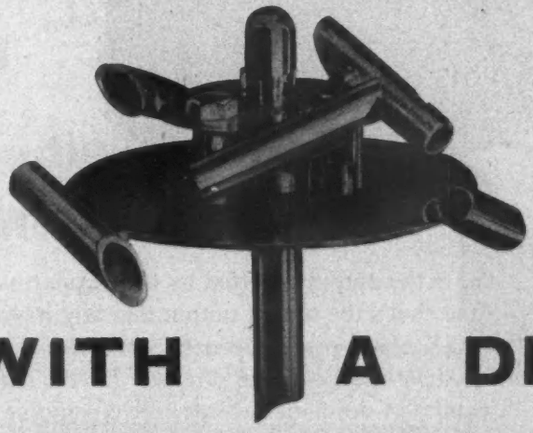
OF EVERY DESCRIPTION AND SIZE

PRESSURE RANGE FROM 5-20,000 lbs. per sq. inch

Prompt Deliveries.
Highest Quality.
Send for Illustrated Catalogue.

EAGLE & WRIGHTS (GAUGES) LTD.
87 CARVER STREET, BIRMINGHAM, 1
Telephone : Central 8196

THE PLENTY IMPELATOR



MIXING WITH A DIFFERENCE

This unique type of mixing head gives very rapid dispersion and circulation for all industrial applications. Speeds can be adjusted to give violent agitation with or without aeration, whilst gentle stirring can be carried out with the greatest efficiency. Available in all sizes either for fitting to existing mixing equipment or complete with Motors, Starters and Mixing Vessels. Why not put your problems or write for a leaflet to—

Eagle Iron Works
Phone: NEWBURY 2363 (4 lines)

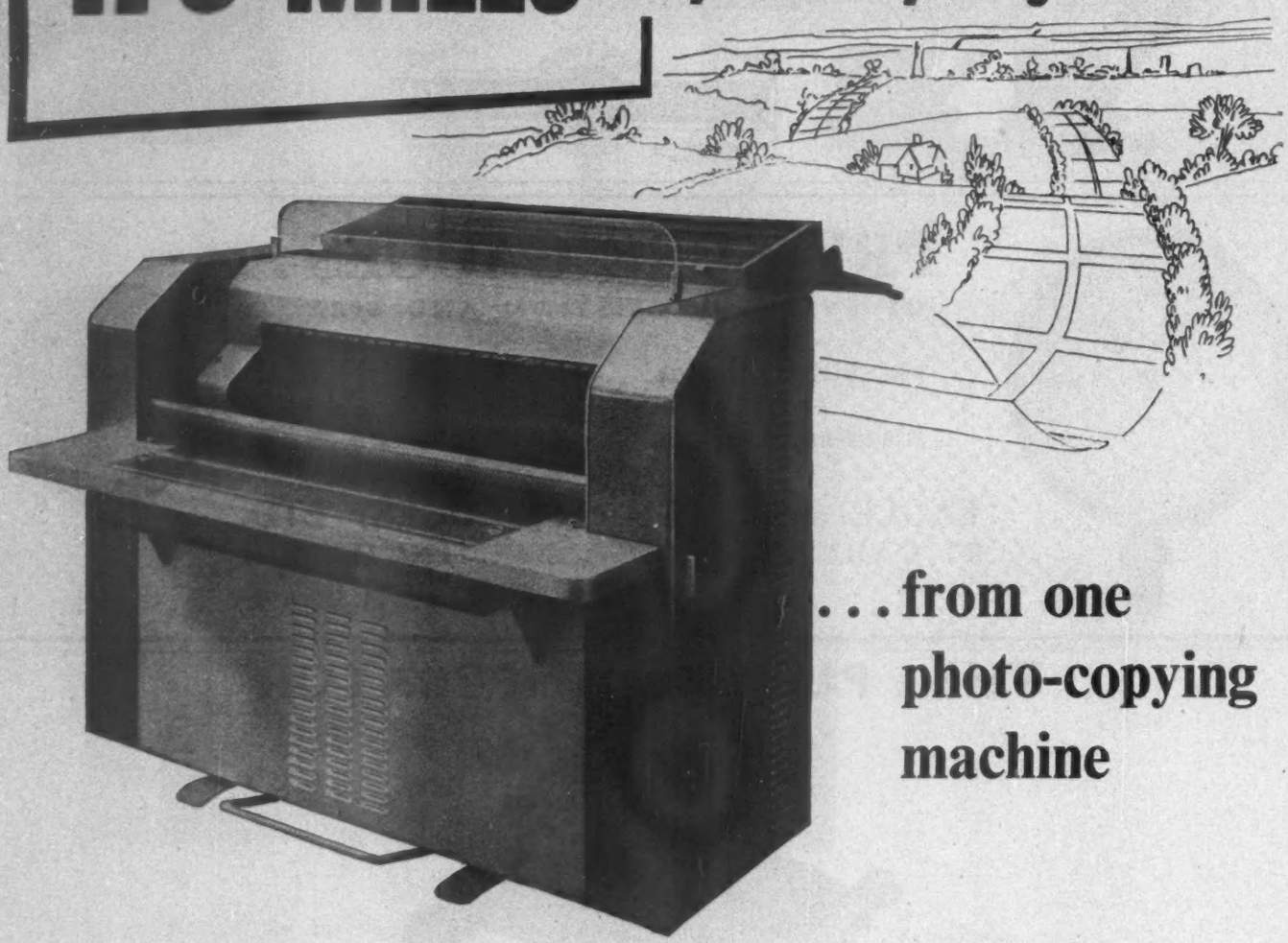
PLENTY & SON Ltd.

Newbury, Berks.
Grams: PLENTY, NEWBURY

Covered by Patent No. 695227 and Design No. 862551 and Patents pending. "Impelator" is the registered trade name of Plenty & Son Ltd.

Also makers of MARINE ENGINES *and* STERN GEAR, ROTARY DISPLACEMENT PUMPS *and* FILTERS E.N.

175 MILES *of prints per year...*



...from one photo-copying machine

175 miles of prints a year is the output reported by one regular user of an Azoflex Model 46/35—and that's the sort of output that any busy drawing office can expect. The AZOFLEX photo-printing process combines several unique features. It's the *only* daylight reflex copying process. It's the *only* process to apply a measured quantity of developer irrespective of running speed, thus ensuring optimum quality. It avoids the use of dangerous chemicals and there are no unpleasant fumes. Operation is quiet and free from vibration. Exposing, developing and print delivery are all synchronised to ensure an even flow of finished work at all speeds.

AZOFLEX MODEL 46/35 combined synchronised printer and developer. Capacity: cut sheets and rolls up to 42 in. wide. Printing speed: up to 30 ft. per minute. Dimensions: Height 58 in. Depth 60 in. Width 72 in. Weight 1,100 lb. Price £1,555 (including delivery and installation in the U.K.).

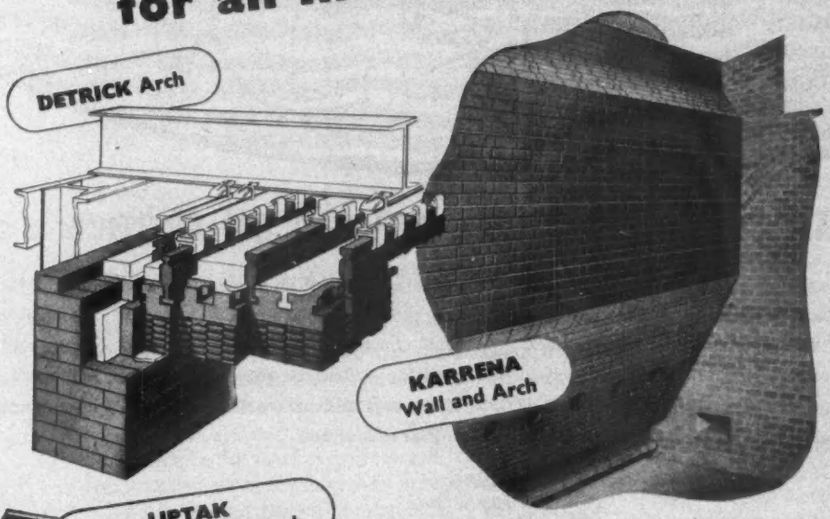
ILFORD *Azoflex*

Enquiries to: Ilford Limited, Industrial Sales Dept. AZ11H, Ilford, Essex. Telephone: ILFORD 3000

PHOTO-PRINTING MACHINES AND MATERIALS

GLENBOIG FIREBRICKS

for all Industrial Purposes..



...including all types of SUSPENDED WALLS and ARCHES

THE GLENBOIG UNION FIRE CLAY CO LTD · GLENBOIG · LANARKSHIRE · SCOTLAND
Export Agents GENERAL REFRACTORIES LTD · GENEFAX HOUSE · SHEFFIELD 10

Boilerine Ltd.
Manufacturing Chemists

Boilerine
Descaler For Steam Boilers
Torrefine
Bottle Washer
Torrefine Cream
For Glass Lined Tanks
Organic Rosseline
Domestic Boiler Descaler
Chromium Polish
Chromium Cleaner
Torrefine Household Cream
For Gas Stoves and all Domestic uses
All enquiries & orders will receive prompt attention
885a to 897 OLD KENT ROAD, LONDON, S.E.15.
Telephones: NEW CROSS 0061-2

BRITISH SPRINGS AND WASHERS

B S & W

WILLIAM FINUCANE (Springs and Pressings) LTD.

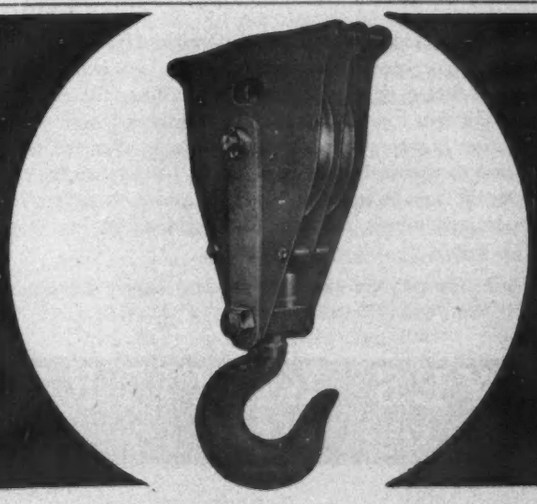
A.I.D. A.R.B.

ELGAR 3757/8/9
16A, HILLSIDE, STONEBRIDGE PARK, LONDON, N.W.10

THERMOSTATIC VALVES

for CONTROLLING STEAM SUPPLY TO HOT WATER CALORIFIERS. Etc.

The HORNE ENGINEERING Co. Ltd.
35 PITT STREET, GLASGOW



LOVERIDGE LTD

151-153 BUTE STREET, DOCKS, CARDIFF

Manufacturers of High Class
CRANE BLOCKS
PULLEY BLOCKS
& PATENT SNATCH BLOCKS for Wire Rope

Telephone: CARDIFF 23641 Send for Brochures

Water treatment problems come in all shapes & SIZES

For more than fifty years Paterson have been solving a multitude of water treatment problems, some for municipal undertakings, others for industry, many for organizations abroad. Not all these have been straightforward, and only a few have resembled others. But they all had in common a demand for a solution that combined absolute efficiency with utmost economy. With these ends never out of sight, Paterson have produced plant to treat water for use in as many ways as could conceivably be needed. Softening, filtering, clarifying, purifying — Paterson plant does all this, and much more. That's why, whatever the shape or size of *your* water treatment problem, it's certain . . .

. . . to be solved by **Paterson** *plant for pure water*

LET US CONSIDER YOUR PROBLEM. The Paterson Engineering Co. Ltd., 129 Kingsway, W.C.2. Tel. HOLborn 8787

NOW 100 TONS CAPACITY

Hydralite

The latest addition to this standard range of light-weight Hydraulic Jacks incorporates a new Tangye two-speed hand pump (A); the two speeds giving high or low pressure are selected by a push button (F). When the button is in an 'OUT' position, the ram can be pumped out rapidly and raise a load up to 10 tons. The button is then pushed to 'IN' position, when the pump operates on high pressure to enable the raising of up to 100 tons on the ram. Pressure release to lower the ram is by hand wheel (B) which operates a sensitive needle release valve and allows a controlled descent of the ram under load. The power lift is 6 in.

Other items: (C) provision for pressure gauge or pressure supply connection; (D) oil filter; (E) cistern vent; and (G) operating shaft.

TANGYES LIMITED
SMETHWICK - BIRMINGHAM

No. Ad. 51

THE ENGINEER

No. 5346 JULY 11, 1958 VOL. 206

SETTING THE SEAL ON WINDSCALE

No. 1 pile at the Windscale plutonium factory cost £3,700,000 to build, and it looks as if there will be no further return on the investment. Last week, Sir William Cook said that, inside the Atomic Energy Authority, opinion leaned heavily in favour of abandoning the pile. Presumably expecting that the official decision will follow this feeling, members of the Authority are now considering how to seal the pile and how to use the unaffected part of the building that houses it. No. 2 pile, which was not injured in the accident last October, can be run again, but apparently it will cost more than £500,000 to do what is required before the pile may be started. An assessment of what is technically necessary was published as a White Paper on July 3, and the recommendations are reported elsewhere in this issue. The assessment of what is *financially* necessary will take another two to four months, however, for it is by no means clear yet whether the life that could remain to the pile would be worth buying at the price. Designed for an active existence of ten years, the pile has done about three-quarters of its time, and although some extension of its anticipated span may be found to be possible, this may not be enough to justify restoration ; No. 2 may well follow its partner into the heritage of mute inglorious monuments which the nuclear age is going to bestow upon us.

It is providential that the first of these great tombstones should mark the death, not of man or beast, but of an interval of half-knowledge and over-confidence. There is no reproach in these last words : the half must precede the greater fraction, and we feel sure that over-confidence at Windscale was the consequence, not of presumption or inhumility, but of just this insufficiency of knowledge. A great deal has been learnt since the Windscale piles were designed, and some of the lessons are hinted at in the White Paper. This gives a general account of the problems that are created by the way in which energy is stored when neutrons knock atoms out of their accustomed places in graphite. A modified procedure for annealing away this energy was tried on BEPO at Harwell recently, and according to the final Fleck report embodied in the White Paper, the method was successful. All that was done was to put electric heaters into the inlet ducts and warm the graphite by blowing hot air through the core ; previously nuclear heating had been employed. Apparently this technique would not be applicable quite as simply to Windscale pile No. 2 because some danger of overheating would be present there. It would be necessary to raise the temperature of the graphite slowly to 120 deg. Cent. by heating the ingoing air, hold the temperature at this level for about twelve hours, and then cool to room temperature. This preliminary annealing would release some of the stored energy, and so reduce by about 80 deg. Cent. the maxima of temperature that might be reached in a self-sustaining release. It would be permissible after this to raise the graphite temperature rapidly to 160 deg. Cent. by heating the ingoing air, and thus release the remaining energy. Happily, annealing processes of this kind are very unlikely to be needed in the civil power reactors because they will run at higher temperatures than the military piles.

It is thought that, if the decision goes in favour of rehabilitating No. 2 pile, then it would be running again by late 1959 or early 1960. Clearly a great deal of work would be necessary to procure and install the equipment for annealing the pile, and to place the many extra thermocouples, &c., that are now deemed to be necessary for the sure running of a reactor. Were it not that there is a risk of shortage in the country's store of plutonium, it might seem that the case against resuming work with No. 2 pile was especially strong. However, that the risk exists was shown by the recent decision " to provide insurance against future defence needs " by taking plutonium from the reactors employed in the civil power stations, and this, coupled with the recent setback at Calder Hall " B " station, may make effort on the Windscale pile seem to be more worth-while.

CHARLES DICKENS AND TECHNICAL EDUCATION

In a speech delivered by him almost exactly a century ago—he was addressing the Institutional Association of Lancashire and Cheshire in the Free Trade Hall, Manchester—Charles Dickens uttered some words of encouragement and advice to men who, though their business in life was " with tools and with machinery," were eager and painstaking in their search for knowledge. Among those who, having gained distinction in examinations, were present on this occasion to receive awards, were " two poor brothers from near Chorley, who work from morning to night in a coal pit, and who, in all weathers, have walked eight miles a night, three nights a week, to attend classes." There were also " two poor boys from Bollington who," said Dickens, " began life as piecers at one shilling or eighteen-pence per week. These poor boys will appear before you tonight to take the second-class prize in chemistry. There is a plasterer from Bury, sixteen years of age, who took a third-class certificate last year at the hands of Lord Brougham ; he is this year again successful in a competition three times as severe .... There is a moulder in an iron foundry, who, whilst he was working twelve hours a day before the furnace, got up at four o'clock in the morning to learn drawing." Dickens quoted other and impressive examples of that thirst for knowledge which, surmounting all obstacles, led men to distinction. What they put forth in effort came back to them in achievement and in character. When we remember that Dickens was speaking a century ago and at a time when scant recognition was given to the need for promoting technological education, we shall note the range and shrewdness of his outlook.

Dickens would have agreed that if the object of education is to render a man happy, busy, beneficent and

effective in the world, it cannot be arrived at on the basis of a purely technical education. Sir Winston Churchill has remarked that " The first duty of a university is to teach wisdom, not a trade ; character, not technicalities. We want a lot of engineers in the modern world, but we do not want a world of engineers." We have also to keep clear of the variety of education which, imposed on Germany by the Hitler régime, concentrated upon implanting in the mind of the young that *auswärtige kulturpolitik*, translated by Benjamin Kidd as meaning, in practice, " the continuous presentation of national conceptions to the young mind of Germany." The future progress and tranquillity of the human race depends in great part upon the success with which education can be effectual in cleansing mankind of such barbarisms. In technical education as in any other kind of education we lack such devices as are now available to the metallurgist whereby defects may be rendered visible and unsuitable material rejected. The greatest contribution which technical education can make to the needs of to-day lies in the encouragement of imaginative powers wherever and whenever they can be recognised. After this, the main objective should be to establish the sovereign importance of work, well described as " the open sesame to every portal, the great equaliser in the world, the true philosopher's stone which transmutes all the base metal of humanity into gold." Technological progress follows when the questing spirit is allied with work. How supremely valuable would be an instrument capable of detecting, in aspirants for technological instruction, the latent existence of imagination and industry !

We began by quoting a speech delivered at Manchester a century ago by Charles Dickens. Nowhere in this speech did Dickens disclose a higher order of wisdom than in what might be called its peroration, when—in words declared to be " out of my own own personal heart "—he stressed the need for imagination as well as science. " Do not let us," he says, " in the midst of the visible objects of nature whose workings we can tell in figures ; surrounded by machines that can be made to the one-thousandth part of an inch ; acquiring every day knowledge which can be proved upon a slate or demonstrated by a microscope, do not let us, in the laudable pursuit of the facts that surround us, neglect the fancy and the imagination which equally surround us as a part of the great scheme."

COMPREHENSIVE LIST OF ENGINEERING RELICS

In a recent Bulletin of the Newcomen Society attention is drawn to a discussion which took place a short while ago between the President, the Hon. Secretary and Mr. Stowers upon the Society's side and Sir Eric Seal, deputy secretary, and Mr. Root, under-secretary, Ministry of Works, for the Government. The question at issue was that of the preservation of historic relics on site as affected by the provisions of the Town and Country Planning Act 1947 and the Historic Buildings and Ancient Monuments Act 1953. We are glad to hear that Sir Eric Seal showed a sympathetic interest in the problems with which the Society is faced and, as an encouraging sign of that interest, that it was agreed the Society should submit to him a list of relics which in its opinion ought to be preserved on site and for the preservation of which Government support, financial or otherwise, should be given. Brief particulars had already been given to Sir Eric of the Stretham engine and scoopwheel, the Abbeydale works, the Coalbrookdale furnace and the tidemill at Woodbridge. The Society is, however, well aware that there are many other historic engineering relics on sites throughout the country. With such encouragement from the Ministry it now thinks that it would be worth while to attempt the compilation of a comprehensive list and it is asking all members who have knowledge of such a relic to send brief particulars to the Hon. Secretary at the Science Museum, South Kensington. Obviously it would be as happy to hear from non-members. In making the request it emphasises that " considerable discrimination will have to be exercised in compiling the list " and that, therefore, " it may not be possible to include all relics nominated by members." The Society, we suppose, has it in mind that the list to be presented to the Minister must not seem too formidably long and must relate only to relics which are of such importance and in so sufficient a state of present preservation that every endeavour ought to be made to preserve them on site for posterity. But having " set its hand to the plough " ought it to stop short at that point ? Even though discrimination must be necessary in presenting a list to the Minister it would still be interesting and of value to place on record, now, information about less important or less well preserved relics which it may prove quite impossible to protect for the future. Certainly, we feel the Society would not wish anyone to hesitate in sending information merely because he felt shy about referring to something really of not much account. Some points do, however, occur to us. How is " relic " to be defined ? How old must a " relic " be ? Must it be out of service ? Is the request intended to apply only to objects which have no other protection than the Government may afford, or also to objects (such for example as the engines preserved *in situ* by the Cornish Engines Preservation Society) which have already found protection by some body or organisation ? It would certainly help people who would like to help the Society if it would define more clearly the kind of relic about which it hopes to receive information and the nature of the information about such relics which it hopes to record.

THE NAVY LOSES SIX MORE CARRIERS

In the light of the present defence policy, the announcement by the First Lord last month in the Upper House of the Government's intention to scrap or sell six aircraft carriers was not unexpected. Indeed, although no explanation was given at the time, five of these ships—the " Unicorn," " Perseus," " Theseus," " Ocean " and " Glory "—were not included in the " Strength of the Fleet " section of the First Lord's Explanatory Memorandum accompanying the current Navy Estimates. The " Warrior," however, has twice been modernised since the war and has been fitted with a partially angled flight deck. But with the rapid developments in aircraft, a great deal of money would have to be spent on her to make her of real value for operations with the fleet. Nonetheless she would still be an effective unit in limited war. It is common knowledge that it is hoped to sell her to Argentina, which has been anxious to have a carrier since the purchase by Brazil of H.M.S. " Vengeance "—a similar ship of the " Colossus " class. In recent years the " Ocean " and " Theseus " have been serving as a training squadron for early entries and the " Glory " has been used for trooping duties. All these four carriers were built during the war for service in the Pacific, when economy in the building of large ships was of great importance. Of only 13,190 tons standard displacement

and a speed of 24 knots they are too small and too slow for operating even the existing jet aircraft in naval service to-day with the rapidity and efficiency required. All—the "Warrior" to a lesser extent—would require considerable reconstruction to meet modern requirements. The "Perseus" and "Unicorn" are approximately similar in size and speed but are in fact nothing more than maintenance and replenishment ships for aircraft.

The Government scarcely conceals its view that if the deterrent fails, thermo-nuclear weapons would bring a war to an end in a very short time. Whether one accepts this view or not there can be no doubt that the ships of the Royal Navy must be modern and available at very short notice in the event of a global war. And if Britain is to continue her policy of concentrating on measures for preventing rather than for waging war, she cannot afford to modernise ships which will not be of first rate fighting value. It is wise, in this connection, to remember experiences with the "Victorious." Though a pre-war designed carrier, she is large and very fast and now that she has been modernised she meets requirements in every way and is one of the finest carriers in the world. But it took nearly eight years and a very large sum of money to modernise her. None the less when the "Hermes" is completed Britain will only have seven front line carriers —a number only sufficient to maintain four in active service with the Fleet. This can hardly be described as "making an effective contribution to the combined naval forces of the Western Alliance"—the task which the Government, in deference to public opinion, has now given to the Royal Navy in global war. To make "an effective contribution" Britain must build new carriers. And they could be built—together with the relatively small nuclear powered anti-submarine submarines which are urgently required—without detriment to the deterrent capability.

V-bombers, with their stand-off guided flying bombs, will continue for many years to be the most effective deterrent. But there is little use in supplementing them with the United States "Thor" land-based intermediate range ballistic rockets which could not reach the industrial areas in eastern Russia. As we have frequently pointed out in these columns, a safer and more effective deterrent can best be provided by ships—preferably large nuclear powered submarines—from which rockets, launched from the vicinity of an enemy's coast would reach all important war potential targets. Britain cannot at present afford to build new ships costing between £20,000,000 and £30,000,000 for the sole purpose of launching ballistic rockets. But she can well afford to convert existing vessels. Instead of scrapping these six carriers, we suggest that their hangars and other installations needed for aircraft should be removed and the space thus made available used for the carriage of anything up to fifty "Polaris" rockets. It has been argued that surface ships, even though sent to sea on the outbreak of war, would be very vulnerable. But those who rightly maintain that the Royal Navy's contribution to N.A.T.O. should be more effective cannot have it both ways. What is the Royal Navy for but to safeguard sea communications? And if Great Britain intends to protect her merchant ships she can surely provide adequate protection for her ballistic rocket carriers.

AIR REGISTRATION COMES OF AGE

We enjoyed last week the opportunity to congratulate the Air Registration Board, through its redoubtable chairman, Lord Brabazon of Tara, upon the coming of age of that body, which was celebrated at the twenty-first annual luncheon. Twenty-one years may not seem long, particularly when one is seated in a building, such as the Vintners' Hall, the history of which is counted in centuries, and that it is but a fraction of a life-time is emphasised when we observe that four of the original members of the Board are still active, while a fifth, Sir Frederick Handley Page, resigned during the last year. But those few years encompass nearly half the history of flying in these islands, as Lord Brabazon observed, and more than half of our progress. In 1937 we recorded that the Board would not be responsible for "the big four-engined air liners of Imperial Airways": those aircraft possessed as much power as each engine on their modern equivalents—although it should not be forgotten that door-to-door the London-Paris journey then was quicker than it is to-day!

During this rapid advance the Board which, as its present chairman observed, must beware of acting as a brake on progress, has naturally sometimes made faulty decisions: debate as to its merits was perhaps loudest after the catastrophic failures of the pioneer jet airliner. But even in this extreme case the aircraft builders and operators, who are the first to suffer from bad decisions by the Board, remained convinced that no consideration of prestige or priority would sway the Board from what it held to be technical rectitude. The support the Board enjoys can be attributed to the fact that the interested parties are represented thereon, and the success it has attained derives from the phenomenon, observed by Lord Brabazon, that in this country interested parties lean over backwards to be fair. In the present, when the prosperity of manufacture and transportation is vital to Great Britain, and when the government is taking, directly and indirectly, a greater and greater part in directing the designer and operator, much good might come from studying in detail the proceedings of the Board. We note particularly the insight shown in the Chairman's latest report: "Neither seaworthiness, roadworthiness, nor airworthiness are absolutes"—once it is realised that the problem is to measure these qualities, progress may be possible.

The Engineer — 100 Years Ago (JULY 9, 1858)

"ROTATION BY ELECTRICITY"

"At a recent meeting of the Royal Society an ingenious and curious apparatus was exhibited, displaying the rotation of a metallic sphere by electricity. The apparatus was contrived by Mr. Gore, of Birmingham, who stated that his experiments had their origin in a phenomenon observed by Mr. Fearn, also of Birmingham, in his electro-gilding establishment—that a tube of brass half an inch in diameter and four feet long, placed on two horizontal and parallel brass tubes, one inch in diameter, and nine feet long, and at right angles to them, and the latter connected with a strong voltaic battery consisting of from two to twenty pairs of large zinc and carbon elements, the transverse tube immediately began to vibrate, and, finally, to roll upon the others. Acting upon this, Mr. Gore constructed a disc of wood provided with two brass rails, level, uniform, and equidistant; on these rails a hollow and very thin copper ball was placed, and the brass rails being connected with a zinc and carbon battery, the ball began to vibrate, and presently to revolve. In all cases yet observed, Mr. Gore states that the motion of the ball is attended by a peculiar crackling sound at the points of contact, and by heating of the rolling metal. When the apparatus was exhibited before the Royal Society, electric sparks were seen as the ball rolled from the spectator."

"HOT AIR ENGINE FOR EGYPT"

"A hot air engine was shipped for Egypt from New York by the Ericsson Co., on the 9th ult. It is designed to pump water from the famous river Nile, to supply one of the palaces of the Pasha."

North of Scotland Hydro-Electric Schemes

No. IX: THE BREADALBANE SCHEME—PART I*

St. Fillans power station, right, one of four principal power stations in the Breadalbane group of schemes, was inaugurated on June 28, together with the small station at Dalchonzie, immediately below it in the same catchment. The group of schemes as a whole is well on the way towards completion and is described here. In many respects it is typical of Scottish water power, but includes a number of features of special engineering interest which we have tried to emphasise in the ensuing description. The whole scheme will produce about 370 million kWh annually from an installed capacity of some 120MW.

THERE are four hydro-electric developments, each strictly speaking a separate scheme, which fall within the general group known as the Breadalbane scheme. The individual power stations and reservoirs are thus of moderate size, but the scheme as a whole gives an appreciable yield of power. Its scope has been increased as far as possible by extensive diversions of neighbouring catchments, and these works, together with a fairly high rainfall, have enabled nearly 400 million units to be gained each year from within an area some 25 by 30 miles in extent.† All this involves the construction of eight dams and about 60 miles of tunnels and aqueducts.

The accompanying map shows how the power has been won. To the south-east is the St. Fillans section, the main stage of which comprises the Lednock reservoir with a main tunnel and pressure shaft leading from it to the underground power station at St. Fillans. Various collecting works increase the flow into Lednock reservoir, including the Breaclaich works. The natural outlet of Loch Breaclaich is being dammed, to give a sizeable reservoir at a slightly higher level than Lednock reservoir. There is thus a small power station between the two. The tail-race of St. Fillans station leads into Loch Earn. A subsidiary stage has been added by constructing a weir to control the outlet of Loch Earn, and incorporating beside it an intake leading to a tunnel terminating at the Dalchonzie station.

To the west of the St. Fillans section is a small single stage project—Luib—construction of which is not being undertaken at present.

On the north slopes of Loch Tay, and again to the eastwards, is the Lawers scheme, comprising the classical single-stage development of reservoir, tunnel, pipeline and power station, with aqueducts feeding into the reservoir. This scheme was promoted before the rest of the Breadalbane scheme, and its power station was commissioned in 1956. Finlarig power station operates with the highest head of any of the Board's schemes.

The Killin section is a two-stage scheme. The upper reservoir is to be formed by the enlargement of two small lochs on a head stream of the river Lyon, and is known as Giorra reservoir. It regulates the tunnel and pipeline serving Cashlie power station. The reservoir of the lower stage is at Lubreoch. In the scheme as originally planned, the upper-stage power station would have discharged directly into the second main reservoir. But alterations were made to satisfy the fishery and amenity committees, in which the size of the lower reservoir was reduced, and it was sited further upstream. Thus Lubreoch reservoir discharges through a small power station, which simply utilises the head given by the dam, back into the river. This controlled flow is held up in a head-pond at Stronuich into which the tail race of Cashlie power station will also flow, and it is from here that the main tunnel leads off under the watershed to the Lochay valley, terminating in a steel pipeline and Lochay power station, where the bulk of the generating capacity of the Killin section is concentrated.

The principal data relating to these four sections are summarised in the accompanying tables. The scheme as a whole has exploited an area immediately to the south of the Tummel-Garry scheme. To the south-west of it lies Loch Katrine—the source of Glasgow's water—and further west the Loch Sloy group of schemes. Rainfall in the Breadalbane catchments is less than the extreme amounts which fall on the west coast, but still heavy and in the average year varies from about 110in to about 60in throughout the catchment, the higher figure being relevant to the western areas and to the highest ground.

Killin is an important centre for the 132kV Highland grid, and the power generated by the Breadalbane group is taken through a switching and transforming station at Killin, which is also a group control centre for the entire Breadalbane scheme. The Highland grid is connected to the South of Scotland Electricity Board's grid at two points—Windyhill and Bonnybridge—and the lines making these connections start respectively from the Sloy and the Tummel-Garry schemes. The inter-connecting line between Sloy and Tummel-Garry passes through the Breadalbane area, and Killin is at about the mid-point of this line.

TABLE I—*Power Stations of the Breadalbane Scheme*

Power station	Sets installed and capacity, MW	Max. gross head, ft	Average annual output, kWh × 10^6	Load factor, per cent
St. Fillans section:				
Lednock	One Francis set... ... 3·0	314	7	36
St. Fillans	One Francis set... ... 21	838·5	75·5	41·5
Dalchonzie	One Kaplan set... ... 4	102	17·5	50
Lawers section:				
Finlarig	One horizontal-shaft Pelton set with two turbines 30	1345	80	30
Killin Section:				
Lubreoch	One Kaplan set... ... 4	96	13	37
Cashlie	One Francis set... ... 11	470	23	24
Lochay	2 by 22·5 Francis sets 47 1–2MW Pelton compensation water set	585	152	37
Stronuich	Compensation water set 0·2	40	1	57
Lochay fish pass	Compensation water set 0·05	58	0·3	68
Totals for present works	120·00	—	369	35
Luib section:				
Luib	6	965	15	32

TABLE II—*Reservoirs*

	Useful storage capacity, cubic feet × 10^6	Top water level	Associated catchment Area, square miles: Direct	Associated catchment Area, square miles: Indirect	Total
St. Fillans section:					
Breaclaich	229	1456	1·5	9·3	10·8
Lednock	1·060	1156	7·4	33·4	40·8
Loch Earn	520*	317·5	46·3	3·0	49·3
Totals for St. Fillans section			55·2	45·7	100·9
Lawers section:					
Lochan-na-Lairige	460	1710	1·7	15·5	17·2
Killin section:					
Lubreoch	2930	1127	26·9	28·3	55·2
Giorra	1580	1421	10·7	6·8	17·5
Stronuich	30	959	9·0	6·1	15·1
Totals for Killin section			46·6	41·2	87·8

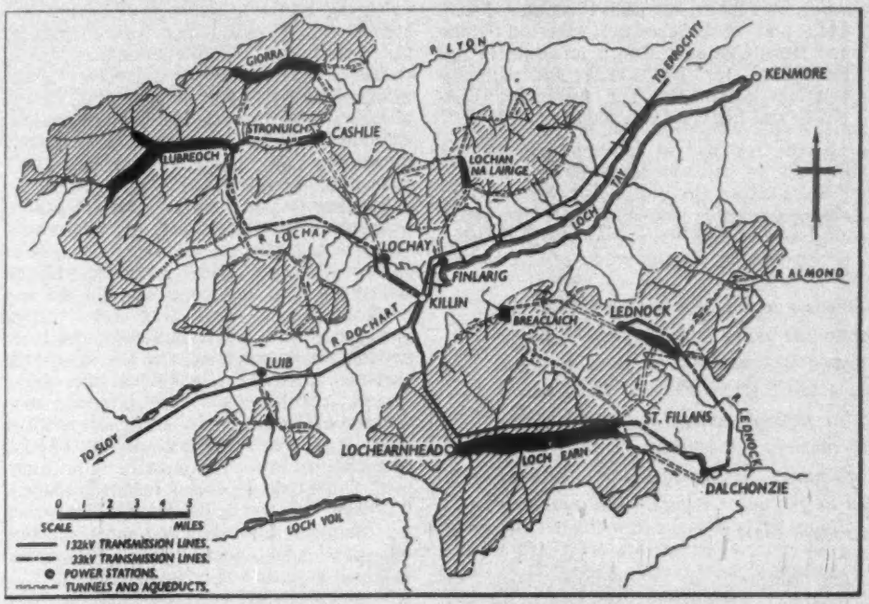
* Between 317·5 and 312·5 O.D. The catchment areas entered against Loch Earn exclude the Lednock catchments.

* No. VIII, The Garry and Moriston Schemes, appeared October 5–November 9, 1956.

† The actual catchment areas utilised total about 202 square miles.

The various firms of consulting engineers responsible to the North of Scotland Hydro-Electric Board for the Breadalbane works are, for civil engineering, Messrs. James Williamson and Partners (Killin and Lawers sections) and Sir Murdoch MacDonald and Partners (St. Fillans section) with Messrs. Duff and Geddes in association with R. H. Cuthbertson for the Breaclaich dam. For the electrical and mechanical design, Messrs. Merz and McLellan (Killin and Lawers) and Messrs. Kennedy and Donkin (St. Fillans) and Messrs. Strain and Robertson (Lednock power station) are the consultants.

In the more detailed description which follows, we give first some notes on the mechanical and electrical aspects of the St. Fillans section, covering the two power stations which have just been opened.



Principal works of the Breadalbane scheme. The scheme is in four sections—St. Fillans, Lawers, Killin and Luib

St. Fillans Power Station

The underground power station is finding increasing favour in the Board's more recent schemes, wherever rock conditions promise favourable constructional cost. The impact of each scheme on the "amenity" of the Highland glens is always carefully considered. Generally, the approach has been to make power stations and other such structures as unobtrusive as possible; thus, the absence of a surface station, and, more particularly still, the absence of a pipeline, is considered advantageous. The underground power station, however, has its own special architectural appeal, and the station at St. Fillans is a good exampie of the style which the Board is encouraging for these underground installations.

There is only one principal generating set, and the entrance tunnel leads into the loading bay of the station at the main floor level. The alternator, control cubicles and switchgear are accessible at this level, but there is a half-floor cut away to give access to the turbine gear and auxiliaries and the main inlet valve at the lower level. The power station crane is carried on reinforced concrete columns and crane beams, and the natural rock is exposed in the large panels which they form, except in areas where unsound rock has been exposed, and hence has required a surface rendering. The exposed rock is illuminated by lights under the crane beam. Its roughness contrasts with the floor finishes and the machines themselves, which are painted in light colours.

The turbo-alternator set has a vertical shaft and is powered by a Francis turbine. The turbine has a rated output of 30,000 h.p. at 785ft net head when running at 600 r.p.m. The runner is of cast stainless steel and the wicket gates are of cast steel with stainless steel sealing faces welded on, but most of the remaining parts, including the spiral casing assembly, are of fabricated mild steel, the more important members being stress relieved where necessary. The turbine inlet valve is a "Rotovalve" which is solenoid-controlled, with its hydraulically operated servomotor fed from the pressure penstock.

Auxiliaries comprise a governor oil pumping set, two station drainage pumps, and two cooling water pumps which also serve when the penstock and tail-race system has to be drained.

The rather high station head of 785ft has been obtained without a long penstock system because of the steeply sloping terrain in this area. The surge shaft is thus quite close to the turbine, and hence, by accepting a slightly increased pressure regulation figure, it was possible to dispense with the pressure relief valve. Savings in excavation costs, particularly since the station is underground, were thus achieved.

The vertical-shaft salient-pole synchronous generator has a rated output of 21MW at 0·85 p.f. and 11kV and is a totally enclosed air-circuit, water-cooled machine. Air can be bled off to heat the station and there is a filter screen for make-up air.

The main combined thrust and journal bearing for the set is mounted on the upper bracket of the alternator; this bearing, the lower alternator guide bearing and the turbine guide bearing are all of oil-immersed design with integral water cooling coils.

Main and pilot exciters are provided, the latter giving a source of d.c. supply for the motor amplidyne set of the magnetic amplifier voltage regulator. This results in a self-contained excitation system independent of any external a.c. supply. A permanent-magnet generator is also directly coupled to the alternator shaft, and is the "speed-sensitive" source for the automatic turbine governor.

The turbine, generator, excitation and auxiliaries control panels are mounted as two suites on the upper (main) station floor. From this control point the set may be started up to "ready to synchronise" either electro-manually or alternatively entirely automatically by depressing a single "start" push button.

Dalchonzie Power Station

The 4MW induction generator set at Dalchonzie station also has the vertical shaft arrangement and a similar two-floor layout has been adopted in the power station. However, rock conditions were unsuitable for an underground cavern, and the station is a small, stone-faced building placed unobtrusively by the hillside.

The turbine is a Kaplan machine rated at 5600 h.p. at a net head of 86ft for a synchronous speed of 333 r.p.m. The general construction again includes cast steel runner blades, forged steel shaft and fabricated mild steel spiral casing, but the turbine main inlet valve is, in this case, an 8ft-bore butterfly valve. The position of the turbine guide vanes, and hence the amount of generated output, is adjusted by an oil servomotor, which, in turn, is controlled by a motor-operated setting valve.

The induction generator, although in all ways of normal construction, is nonetheless one of the largest induction machines to be commissioned in this country. Its rating is 4MW, 0·89 p.f. leading, 3·3kV when running at its loaded speed of 336 r.p.m.

Transmission, Control and Protection

The main transmission system serving St. Fillans and Dalchonzie stations comprises a single-strung, double-circuit 132kV overhead line from Killin switching station, leading to a 25MVA, 132/11kV transformer outside the entrance of St. Fillans power station and then into 11kV busbars within the underground power station. The smaller sets at Lednock (the Lednock set is not yet installed) and Dalchonzie are connected into the local 33kV distribution system, which supplies Crieff and the surrounding countryside and which is also connected via a 5MVA, 33/11kV reinforcement transformer to the 11kV busbars at St. Fillans power station. The 11kV circuit breakers within St. Fillans power station are air-break devices, that for the main generator being rated at 500MVA, 1600A. This type of switchgear was chosen because of the reduced fire risk requested in such an underground station and because of ease of maintenance. The breakers have resin-insulated busbars. Remote line isolation is performed by a fault-throwing switch.

For the main transformer, equipment has been provided to give differential overload and earth fault protection, whereas for the generator this includes differential, overload, negative phase sequence and over-voltage protection.

The induction generator set at Dalchonzie will have remote supervisory control from a push button system at St. Fillans power station. Run-up of the machine is entirely automatic and synchronising of it to the 33kV system is achieved by speed matching relays. Output control is by the use of the guide-vane-motor-operated setting valve. The run-up scheme required special design because of the high break-away torque associated with Kaplan machines and the low flywheel effect of the induction generator. Indication of power generated, current, voltage and machine speed on this small set is being telemetered by pilot cable to St. Fillans, and

supervisory operation is by telephone-type coded signals. The total power output of all three power stations is to be transmitted from the respective wattmeters to the group control centre at Killin by impulse signals over the interconnecting Post Office telephone channel.

Electrical and mechanical design at the two power stations of the St. Fillans works has been in the hands of Messrs. Kennedy and Donkin, the consulting engineers. The principal contracting firms concerned with this particular aspect of the scheme are listed herewith.

Turbine at St. Fillans, Harland Engineering Company, Ltd. ; turbine at Dalchonzie, Boving and Co., Ltd. ; main generating sets and main 25MVA transformer, Bruce Peebles, Ltd. ; 5MVA transformer at St. Fillans and 4MVA transformer at Dalchonzie, Bonar Long and Co., Ltd. ; 132kV and 11kV switchgear, A. Reyrolle and Co., Ltd. ; 33kV outdoor switchgear at Dalchonzie, Cooke and Ferguson, Ltd. ; power, auxiliary and pilot cables at St. Fillans, Pirelli-General Cable Works, Ltd. ; power and auxiliary cables at Dalchonzie, British Insulated Callender's Cables, Ltd. ; medium voltage switchgear, at St. Fillans, Artic Fuse and Electrical Manufacturing Company, Ltd., and at Dalchonzie, Edward Holme and Co. (1931), Ltd. ; station batteries at St. Fillans, Nife Batteries, Ltd., and charging equipment, Westinghouse Brake and Signal Company, Ltd. ; station battery and charger at Dalchonzie, The Tudor Accumulator Company, Ltd. ; lighting and heating, James Scott and Co. (Electrical Engineers), Ltd. ; station crane, St. Fillans, Marshall Fleming and Co., Ltd., and at Dalchonzie, Wharton Crane and Hoist Company, Ltd. ; and control and indications for Dalchonzie and communications equipment, The Automatic Telephone and Electric Company, Ltd.

(To be continued)

Nuclear Reactor Dynamic Analysis

No. I

To investigate the safety or control of a nuclear reactor requires analysis of the dynamic behaviour of the system following postulated disturbances or during particular operating conditions. This paper, presented to the Institution of Mechanical Engineers‡ by R. Parr, B.Sc., A.M.I.E.E., and D. V. Wordsworth, B.Sc†., derives equations for a static fuel thermal reactor, a static fuel fast reactor, and a circulating fuel thermal reactor. A method of analysis of component temperature variations is presented, with particular reference to a solid fuel-element, with a sheath cooled on the outer surface. We reproduce the paper in abridged form.*

At an early stage in the design of a nuclear reactor it is necessary to consider control and safety. The majority of applications so far have required the reactor to operate more or less continuously at a steady power. It is not, for example, intended to operate the earlier power station reactors as variable-load devices. The operating economics of such stations are such that it will be most desirable to operate them as base-load units. So with the exception of reactors for mobile power units, and some research reactors, the need for frequent variation of power has not arisen. Nevertheless, this does not imply that a reactor design can be assessed without reference to transient behaviour. As indicated above, safety must be considered in detail, and this requires an analysis of the dynamics of the reactor system, for most of the faults likely to have a significant effect on the safety of the plant can be interpreted as specific disturbances to the reactor.

The conditions which could give rise to a dangerous situation are generally associated with excessive temperatures at some point in the reactor system, while the instantaneous reactor heat output, or the neutron density in the reactor core, are not in themselves of prime importance. The designer may wish, for example, to predict the possibility of reaching the α/β phase-change temperature in the uranium fuel, or even the fuel melting temperature, while other features of importance may be the avoidance of boiling in water-cooled systems, either on the fuel element surfaces or in bulk, the prevention of excessive thermal stresses or temperatures at which material physical properties are lowered to dangerous levels, or possible temperature-dependent chemical reactions.

It is convenient to derive the temperature variations in two stages : in the first the dependence of the reactor heat dynamics on the various reactor parameters is considered, and in the second the temperature variations resulting from the heat output transient are derived.

The production of a steady state in a reactor core requires on the one hand a balance between heat production and heat removal from the system, and on the other hand a balance of neutron production, absorption and leakage. These, however, are not independent. The equations developed below indicate the dependence of neutron flux, and hence reactor power, on the " reactivity". A definite rate of change of neutron flux will exist for any net positive or negative reactivity, and a steady state can only result if the net reactivity is zero.

In general, some means of controlling reactivity is required to give a satisfactory control of the reactor and this usually takes the form of control rods, movement of which changes the neutron balance. If such elements were the only means whereby reactivity changes could occur, then the entire safety of the reactor would depend on their operation. It is, however, characteristic of most reactors, particularly thermal reactors, that any reactivity changes will result ultimately in an opposing reactivity change such that a steady state is restored. The extent to which this " self-balancing " effect is present in any reactor is a useful criterion for assessing its inherent safety.

The most significant contribution to the automatic reactivity balance in a reactor arises from temperature changes which occur in the core components following a change in the power level, but of possible importance also, particularly with a high-flux thermal reactor, are " poison " changes which result from a change in neutron flux. Nuclear properties such as fission and absorption cross sections, diffusion and slowing down lengths and resonance integrals, are dependent on component temperatures and densities, and this results in a temperature dependence of reactivity. It is convenient to introduce the concept of " temperature coefficient of reactivity " associated with each component of the reactor, that is, fuel, coolant, moderator, &c., which indicates the extent to which the reactivity of the system as a whole is influenced by the temperature of a particular component. Typical temperature coefficients for a gas-cooled, graphite-moderated system would be $-1{\cdot}5\times10^{-5}$ per deg. Cent. for the uranium and -3×10^{-5} per deg. Cent. for the graphite, while a system using an aqueous solution of uranium sulphate as fuel and moderator might have a temperature coefficient of about 200×10^{-5} per deg. Cent.

In safety transient investigations the above temperature coefficients are of importance as they may give rise to rapid changes of reactivity. Since each component of the lattice will have its own specific temperature coefficient, it is clear that any incident giving rise to a redistribution of the component temperatures must at the same time lead to reactivity changes of the whole system, and for some time unsteady conditions will prevail. In examining reactor safety it is clear that the possibility of such temperatures occurring must be fully examined. Other time-dependent reactivity changes will occur due to the production of poisons, for example, xenon-135 and samarium-149, but these and other changes associated with fuel burn-up will be relatively slow.

Rapid transients are most likely to occur due to either a rapid change of neutron absorption in the system, or a redistribution of component temperatures in the lattice. The first case is illustrated by rapid withdrawal or insertion of the control rods, while the second case may be due to coolant velocity changes (changes in pumping conditions), or may arise from a change external to the reactor. Rapid changes of heat transfer in the heat exchanger, arising maybe from changes in the steam stop-valve setting,

Nomenclature

A—Coolant specific heat.
B^2—Buckling.
C_m—Moderator specific heat.
C_s—Sheath material specific heat.
C_u—Uranium specific heat.
D—Diffusion coefficient.*
D_i—Delayed-neutron density (neutrons of type i).
D_{i0}—D_i in external circuit, at reactor exit.
D_{i1}—D_i in external circuit, at reactor inlet.
$\bar{D}_i$—Mean D_i in external circuit.
h—Heat-transfer coefficient.
H—Heat production rate, per unit volume of material.
k_∞—Infinite multiplication factor.
k_c—Coolant temperature coefficient.
k_{eff}—Effective multiplication factor in a finite system.
k_m—Moderator temperature coefficient.
k_u—Uranium temperature coefficient.
L—Reactor channel length.†
L_1—Extrapolated channel length, for neutron flux distribution.
L^2—Thermal neutron diffusion area.
L_s^2—Neutron slowing down area.
N—Neutron density.
p—Neutron resonance escape probability.
P—Reactor power ; perimeter.
r—Radius.
S_c—Coolant channel flow area.
S_m—Moderator cross-sectional area per channel.
S_s—Fuel rod sheath cross-sectional area.
S_u—Fuel rod cross-sectional area.
t—Time.
t_f—Core circulation time in circulating fuel reactor.
T—Temperature.
v—Coolant velocity in core.
β—Fraction of fission neutrons which are delayed.
ϵ—Fast fission factor.
Σ_a—Macroscopic absorption cross section.
ϕ—Neutron flux.
λ—Decay constant.
ρ—Density.
τ_e—Mean lifetime of thermal neutrons.

* In this text, one-third of the transport mean free path.—ED. THE E.

† This should not be confused with the diffusion length, also impliedly denoted by L. The writers use only the diffusion area, L^2, in their treatment, while the square of the channel length does not appear.—ED., THE E.

* Reactor Engineering Department, A.E.I.-John Thompson Nuclear Energy Company.

† A.E.R.E., Harwell.

‡ Which invites discussion; communications to be received by July 31, 1958, at 1, Birdcage Walk, Westminster, London, S.W.1.

will result in time changes of the cooling-fluid temperature entering the reactor. This may lead to two effects: first, the moderator and fuel temperatures will become variable, and, secondly, reactivity changes may occur due to the temperature changes of the coolant itself.

Kinetic Equations

Although the neutron density, or neutron flux, is probably of direct interest only in a research reactor, the heat production, which is of principal importance in a power-producing reactor, is fundamentally related to the neutron flux and it is necessary to consider the equations governing this. For any physical system, not necessarily a reactor, in which neutrons exist, a balance equation can be expressed in the form

Rate of change of neutron density = rate of production − rate of absorption − rate of leakage.

The interpretation of this general equation in mathematical terms depends upon the theory postulated to govern the behaviour of neutrons in the particular system. In the case of a reactor, and, in particular, one of appreciable physical size, a power-producing reactor, for example, the most commonly used is diffusion theory. Although this can strictly be applied only to mono-energetic neutrons, it can be used to good effect for a reactor provided that the neutrons can be considered approximately as grouped at one, or a number of, representative energy levels.

Based on diffusion theory the neutron balance equation will be

$$\frac{dN}{dt} = \underset{\text{(leakage)}}{D\nabla^2\phi} - \underset{\text{(absorption)}}{\Sigma_a\phi} + \underset{\text{(production)}}{S} \quad . \; . \; . \; . \; . \; (1)$$

As stated above, this can strictly be applied only to neutrons of one energy, S being a term representing the total production of neutrons in the system which have that energy. In a reactor, neutrons will exist with widely different energies, but it is generally feasible to consider them as lumped into a number of mono-energetic groups each of which can be represented by an equation of the form (1). The constants in these equations would then be average values for all the neutrons assumed to be included in an energy group. The ultimate "source" of neutrons in a reactor is in the fission of fuel atoms and, in general, for any energy-group equation, will be partly fission and partly other energy groups. Although the neutron kinetic behaviour can be represented by a number of equations of the form of equation (1) there is little to be gained by considering more than one such equation representing one energy group. Factors can be incorporated to compensate approximately for the influence of the wide variation of neutron energy.

The form of the neutron kinetic equations depends on the basic type of reactor; of particular interest are the thermal-neutron reactor with static fuel, the fast-neutron reactor with static fuel, and the thermal-neutron reactor with a circulating fuel.

Thermal Reactor with Static Fuel

For this case an equation can be developed which represents the kinetic behaviour of neutrons in thermal equilibrium with the moderator used in such reactors, these being considered as grouped together, all with the same energy, which is the mean of the actual energy distribution. An allowance is made in the "source" term to compensate for the fact that the thermal neutrons are actually derived from higher energy levels.

A characteristic feature of the fission of any of the nuclear fuels is that not all the neutrons which are released appear at the same time. The large majority of the fission neutrons is produced practically instantaneously after a fission, but a small and important fraction, the "delayed" neutrons, is emitted from the nuclei of atoms which are formed during the radioactive decay of some of the fission products. As these particular fission products have characteristic decay times, which are appreciable, the "delayed" neutrons have a very different effect in the total neutron balance equation from the "prompt" neutrons.

The "source" term for the thermal neutron balance equation will be

$$k_\infty \Sigma_a \phi (1-\beta) P_p(B^2)$$

where $P_p(B^2)$ represents the loss due to leakage of the prompt neutrons in slowing down to thermal energies. The rate of decay of any one of the fission products from which the delayed neutrons are derived will be $\lambda_i D_i$. The resultant number of thermal neutrons produced will be $\lambda_i D_i \epsilon p P_d(B^2)$, where $P_d(B^2)$ is the factor representing the leakage. The resultant thermal neutron production for all the delayed emitters will be

$$\sum_{i=1}^{6} \lambda_i D_i \epsilon p P_d(B^2).$$

The neutron balance equation for any point in the reactor can then be written as

$$\frac{dN}{dt} = D\nabla^2\phi - \Sigma_a\phi + k_\infty \Sigma_a \phi (1-\beta) P_p(B^2) + \sum_{1}^{6} \lambda_i D_i \epsilon p P_d(B^2) \quad . \; . \; (2)$$

For a bare reactor which is critical, or nearly critical, the thermal neutron flux at any point will satisfy the wave equation $\nabla^2\phi + B^2\phi = 0$. Hence

$$\frac{dN}{dt} = -DB^2\phi - \Sigma_a\phi + k_\infty \Sigma_a \phi (1-\beta) P_p(B^2) + \sum_{1}^{6} \lambda_i D_i \epsilon p P_d(B^2) \; . \; . \; . \; (3)$$

Now $N = \Sigma_a \phi \tau_0$ and $D/\Sigma_a = L^2$, so giving

$$\tau_0 \frac{d\phi}{dt} = -L^2B^2\phi - \phi + k_\infty \phi (1-\beta) P_p(B^2) + \sum_{1}^{6} \frac{\lambda_i D_i \epsilon p P_d(B^2)}{\Sigma_a} \; . \; . \; . \; (4)$$

For a bare reactor an approximation to the fast neutron leakage factors $P_p(B^2)$ and $P_D(B^2)$ is $1/(1+B^2L_a^2)$. As the energy distribution spectra of the prompt and delayed neutrons are different the factors $P_p(B^2)$ and $P_d(B^2)$ should rigorously be treated as different. Negligible error is introduced, however, by taking these factors as identical.

As a means of simplifying equation (4) it is useful to introduce $k_{\text{eff.}}$, the "effective multiplication factor," which is (total neutron production) × (non-leakage probabilities) per neutron absorbed in the reactor, or

$$k_{\text{eff.}} = \frac{k_\infty}{(1+B^2L^2)(1+B^2L_a^2)}$$

where $(1+B^2L^2)$ is the thermal neutron leakage probability and $(1+B^2L_a^2)$ is the leakage probability during slowing down to thermal energies. Substitution in equation (4) gives

$$\tau_0 \frac{d\phi}{dt} = \frac{k_\infty \phi}{(1+B^2L_a^2)} \left(\frac{\Delta k_{\text{eff.}}}{k_{\text{eff.}}} - \beta \right) + \sum_{1}^{6} \frac{\lambda_i D_i \epsilon p}{\Sigma_a (1+B^2L_a^2)} \quad . \; . \; . \; . \; . \; (5)\S$$

The equation governing the formation and decay of any of the delayed neutron emitters is

$$\frac{dD_i}{dt} = \frac{k_\infty \Sigma_a \phi \beta_i}{\epsilon p} - \lambda_i D_i \quad . \; . \; . \; (6)$$

Equation (5) and the set of equations represented by equation (6) govern the time variation of the thermal neutron flux at any point in a nearly critical bare thermal reactor.

To analyse the time-dependence of temperatures in the reactor core the equations governing heat production are required. These can be obtained directly from equations (5) and (6), for the rate of heat production per unit core volume at any point in the core is proportional to the thermal flux there.

§ $\Delta k_{\text{eff.}} = k_{\text{eff.}} - 1$.—Ed., The E.

(To be concluded)

Final Fleck Report on Windscale

The report of the Technical Evaluation Committee that has been studying last October's accident at Windscale has now been published as a White Paper. A summary of the problems of Wigner energy is given, and an abridged version of this is reproduced here, together with a short account of the committee's recommendations and what was said about them at a Press conference last week.

FOLLOWING the accident during a Wigner release at Windscale No. 1 pile last October, and the report of a committee of inquiry under Sir William Penney,* three further committees were appointed under the chairmanship of Sir Alexander Fleck to look into (*a*) the control of health and safety in the U.K.A.E.A., (*b*) the Authority's organisation and staffing, and (*c*) the technical implications of the mishap. The Organisation Committee finished its work last year† and concluded that the Authority was understaffed in its higher levels. The findings of the Health and Safety Committee were published a little later,‡ and recommended the Authority to undertake certain functions, both domestic and national, including the training of specialised staff. The Technical Evaluation Committee has taken considerably longer in its deliberations than was expected, but a White Paper (Cmnd. 471, price 1s.) was published last Thursday containing the final report. This begins with a brief indication of the way in which information was studied. There is then a summary of the problems created by the storage of energy in graphite under neutron irradiation, and an account of the main factors involved in the planned release of such energy. Possible methods of release for No. 2 pile (which was not damaged in the accident) are reviewed, and recommendations made for the future operation of the pile. The relevant differences between the Windscale and other reactors are also discussed. At a Press conference on the White Paper, Sir William Cook, member of the Authority

* See The Engineer, November 15, 1957, pages 695 and 709.

† See The Engineer, December 27, 1957, page 925.

‡ See The Engineer, January 17, 1958, page 108.

for engineering and production, stated that while the fate of the damaged No. 1 pile was not yet officially decided, opinion within the Authority leaned in favour of its abandonment, and methods of sealing were now being examined. The official decision would be forthcoming in the next few weeks. The Technical Evaluation Committee had made its recommendations, but whether it was worth while to start No. 2 pile was still to be determined. It would cost at least £500,000 to make all the necessary modifications, and it was not possible yet to say whether a pile that had been designed for an active life of ten years, and had survived about seven of them, was likely (even with an extended life) to repay such an investment. In Sir William's view it would take two to four months to assess the problem and come to a conclusion. If it were decided to run the pile again, then it should start late in 1959 or early in 1960.

Asked about the implications for the civil nuclear power stations, Sir William said that he thought there would be no need for Wigner releases in these stations because they would run at higher temperatures than the military reactors. It was not quite certain yet, however, and evidence was still being accumulated.

According to the White Paper some of the mass of information studied will be published eventually in scientific periodicals. A general account of the problems involved is included in the paper, and we reproduce an abridged version of this below.

The Problem of Wigner Energy

Wigner stored energy is the extra energy belonging to crystalline defects produced by neutron bombardment, which knocks atoms out of their normal positions. These displaced atoms can move about inside the material and gradually find their way back to normal positions or other configurations ; their stored energy is then totally or partially released in heat.

It is useful to regard a defect as having a certain lifetime, which is the time required for it to release its energy by the process just described. There are two important features of these lifetimes. First, because of differences in distribution of the defects within the graphite and because of differences in the various types of such defects, the lifetimes vary over a very large range at any particular temperature ; for instance, at room temperature they vary from a fraction of a second to some hundreds of years. It follows from this that some defects will disappear and release their energy very quickly, while others will last almost indefinitely. The second important feature of the lifetimes is that they all become shorter as the temperature of the graphite is raised. For those defects that are released within a few hours at temperatures in the range of 100 deg. Cent., the lifetime is reduced by a factor of approximately 2·5 for each 10 deg. Cent. rise in temperature in the range between 30 deg. and 100 deg. Cent. Thus, a defect with a lifetime of one year at 30 deg. Cent. can be released in about one day at 100 deg. Cent. The number of such defects that can be accumulated during one year's irradiation in a reactor such as the Windscale pile is large, and the energy that would be released by them in one day, at 100 deg. Cent., is correspondingly large.

When a defect releases its energy it can, unless removed by a coolant, warm the material and so help other defects to release their energy more quickly. If there is no cooling, therefore, and if there is a sufficient number of defects present, the Wigner release develops at an increasing rate until the stored energy belonging to these defects is released.

This phenomenon has been known for some time, but when the Windscale piles were designed and built knowledge was extremely limited and the conditions under which Wigner energy could be released were not clear. An accidental release of Wigner energy occurred in pile No. 1 in September, 1952, while the pile was shut down and the main cooling fans were off. As a result of a study of this incident, periodic deliberate releases of Wigner energy have since been carried out.

Theoretical and experimental studies of Wigner energy and its release have been made for a number of years and will continue. Much additional information on Wigner energy has been obtained in recent months. A special study of the graphite in the Harwell reactor BEPO was carried out before the recent successful release of Wigner energy in that reactor was undertaken, and similar studies have been made on the graphite in the Windscale and Calder Hall piles.

The main features of the phenomenon of the storage of energy may be summarised as follows :—

(*a*) Total stored energy accumulates with irradiation dose ; because of the very large influence of temperature on the lifetimes of the defects, the rate at which energy accumulates decreases considerably as the temperature during irradiation is increased. It is known that virtually no energy is stored from irradiations at temperatures above 400 deg. Cent., whilst the amount stored at 250 deg. Cent. is small.

(*b*) The energy stored in graphite in reactors operating at low temperatures can be classified loosely into a low-temperature component and a high-temperature component, according to the temperatures at which the energy is readily released.

(*c*) The low-temperature component can be released by raising the temperature into the range 100 deg. to 200 deg. Cent. If the release of this component takes place in the absence of cooling, it will, in general, raise the temperature of the graphite into the range 300 deg. to 450 deg. Cent., the exact temperature depending on the amount of energy stored. There is experimental evidence that the energy content of this component does not increase indefinitely with prolonged irradiation.

(*d*) The release of the high-temperature component begins at about 300 deg. Cent., but is not completed until the graphite is heated to temperatures exceeding 1000 deg. Cent., for it takes place gradually over a wide range of increasing temperatures. Only a small part of it can be released at any particular temperature within this range. For the amounts of irradiation received by graphite in the Windscale reactors the part of the stored energy associated with this component that is releasable in the range 300 deg. to 500 deg. Cent. is not enough to carry the temperature of the graphite much beyond that reached by the release of the low-temperature component.

On the basis of the information now available, and from an examination of the records obtained during previous Wigner energy releases in Windscale pile No. 2, it is concluded that, if a further energy release on this pile were carried out by the method adopted hitherto, graphite temperatures in excess of 400 deg. Cent. would almost certainly occur in considerable masses of graphite. It is impossible, moreover, to rule out entirely the existence of pockets of graphite from which the stored energy was not released on some previous occasion. It is unlikely that there are any pockets in which the stored energy has never been released, but if such pockets did exist releases in them in future could, in the absence of cooling air, lead to graphite temperatures as high as 500 deg. Cent. To check this adequately would involve the extraction from the pile of a very large number of graphite samples.

Since, as stated above, the release of the low-temperature component of the stored energy could lead to temperatures in the range 400 deg. to 500 deg. Cent., it is important to examine the effects of such temperatures on the various materials which are in the pile.

Graphite.—At sufficiently high temperatures graphite oxidises rapidly in the presence of air, with the production of considerable heat. The rate of oxidation, and consequently the rate of heat production, increases rapidly as the temperature rises. It is important to ensure that the graphite in a pile will never reach a temperature at which the rate of heat production by oxidation is greater than the rate at which heat can be removed from the graphite. A great deal of experimental work has been done to study the rate of oxidation of graphite under various conditions, and this work is continuing. It has been found that graphite which has been subjected to prolonged irradiation, as in the Windscale piles, oxidises more readily than unirradiated graphite. It has also been found that quite small quantities of various contaminants, which can be deposited in the graphite of a pile from the air used to cool it, greatly enhance the rates of oxidation.

The temperature to which the graphite in a pile can safely be permitted to rise depends on : (*a*) the oxidation rate, and (*b*) the amount of cooling available. Present information indicates that the full cooling provided by the main blowers of pile No. 2 would be sufficient to remove the heat produced by oxidation of the graphite at temperatures up to about 550 deg. Cent. If reliance had to be placed on the present shut-down fans, which are the only ones connected to a guaranteed (emergency) electricity supply, the permissible maximum temperature on the basis of present information is about 450 deg. Cent. However, there may be regions in the graphite where the effect of contamination mentioned above is very large and where, as a result, the permissible maximum temperature might be somewhat less. Therefore it would be unwise with the present shut-down fans, to carry out any operation likely to lead to graphite temperatures in excess of 400 deg. Cent. (For reactors such as those at Calder Hall, which are cooled by carbon dioxide instead of air, these considerations do not apply since no heat is liberated when graphite and carbon dioxide react. On the contrary, heat has to be supplied to sustain the reactions.)

Fuel.—The fuel cartridges in Windscale pile No. 2 and in BEPO consist of uranium bars in aluminium cans. The uranium is normally protected from the coolant by the can, but if the can fails some uranium will be exposed to the air and may oxidise. Even a small pinhole in a can may be sufficient to permit oxidation of the uranium to start. If this were allowed to continue the uranium oxide would eventually damage the can and might lead to the exposure of a substantial area of uranium. Uranium oxidation would then proceed more rapidly, giving local heat, and the fission products in the uranium would escape into the coolant and be drawn up the chimney. Thus, the first objective is to prevent a failure

of the can. Much effort has been devoted to the design of cans, and although occasional and usually minor failures occur during normal operation, it is considered that the present design of fuel element is satisfactory.

Since it is impossible to guarantee that uranium fuel cartridges which are being irradiated and are cooled by air will remain completely and continuously sound, safety in reactor operation, both under normal running and during any planned Wigner release, will depend on two things : (*a*) the ability to detect, and then discharge, a faulty cartridge at an early stage in order to prevent further damage to the cartridge followed by an undue release of fission products—adequate apparatus for the detection of fuel element failures must therefore be available at all times ; (*b*) the maintenance of an operating temperature low enough to avoid rapid oxidation of uranium should a fuel cartridge fail.

Other Materials.—Because of the limits to the temperatures which the graphite and the fuel in the reactor can be allowed to reach, certain operating restrictions are necessary. Similar considerations apply for all other materials in the reactor. In particular, it is desirable that these materials should be capable of standing temperatures in excess of the permissible limits for the graphite and uranium. Given this, they could never be the cause of a fire nor would they require the installation of instruments to record their temperature, or the imposition of any additional restriction on the operation of the reactor because of their presence.

On this basis, none of the structural materials in the Windscale reactors causes any problem. The principle is important, however, in relation to any materials inserted in the reactor for the production of isotopes or for irradiation testing and other experimental purposes. In particular, to meet the above conditions it will be necessary to modify the existing design of lithium/magnesium cartridge which is considered to be unsatisfactory.

Instruments

It is necessary to know : (*a*) the temperature and rate of change of temperature in both the fuel and the graphite ; (*b*) the neutron flux and the rate of change of flux ; (*c*) the degree of fission product contamination of the coolant. To obtain this information will require the installation of more measuring instruments, their correct positioning in the reactor and their association with special recording devices. If a planned release of Wigner energy is undertaken, additional instruments to provide further information, especially of temperatures in the reactor, will be needed.

It is recommended that about 100 thermocouples should be provided to measure fuel temperatures (a further 200 would be needed during a Wigner release), and 300 thermocouples should be installed to record graphite temperatures. With this large number of thermocouples, it is essential that the information obtained from them can be displayed in a form which is immediately available to the reactor operator. Such data-processing and display systems have now been developed for normal industrial use.

Although the existing instruments for the measurement of neutron flux in the Windscale piles have proved generally satisfactory in the past, it is recommended that the opportunity be taken of installing improved types of instruments which have been developed since the Windscale piles were commissioned.

The escape of fission products from faulty cartridges in the Windscale pile can be detected in the following ways : (*a*) collection of air samples from individual channels by a scanner behind the discharge face. For its most sensitive operation this device relies on the detection of short-lived gaseous fission products. It is also equipped with filters which extract dust from the air samples. Any appreciable radioactivity in the collected dust can be detected by γ-ray monitors adjacent to the filters. The mechanical working of the scanner has proved satisfactory during normal operation. High temperatures during previous Wigner releases have led to jamming of the scanner and, if similar releases were contemplated in future, measures would have to be taken to eliminate this defect ; (*b*) the collection of air samples by nine " horns " fixed in a vertical line in each outlet duct so as to cover all levels from the floor to the roof of the duct. These horns feed equipment similar to that used in the scanner for detecting gaseous fission products or solid particles deposited in filters.

Short-lived gaseous fission products of high activity decay during shut-down, and so the longer-lived fission products only are available for detection. The relatively high background radiation from other materials present reduces the sensitivity of the detection of these long-lived products.

When work such as charging and discharging is to be carried out from the charge hoist, it is necessary, because of radiation tolerance limits, to shut down the pile or to reduce its power below that at which the detection of short-lived gaseous fission products is effective. In view of the low probability of a failure occurring during such an operation, and since a means of detecting long-lived fission products continues to be available, such a shut-down is safe. However, current investigation into the improvement of the detection system for longer-lived fission products should be pursued.

Filters

The BEPO reactor and the Windscale reactors are cooled by air which is then blown into the atmosphere. This air may carry with it radioactive particles which have been produced either by the irradiation of particles blown through the reactor or by a failure of one or more fuel cartridges. It is impossible to ensure that no radioactive particles at all enter the chimneys of the BEPO and Windscale piles. However, to minimise the amount of radioactivity that can escape from the chimney on the occasions when a fuel element fails, filters have been fitted which retain a considerable proportion of any radioactive materials there may be in the stream of air passing through them. The filters played an important part in reducing the hazard to the public arising from the accident.

The most important factors governing the efficiency required from the filters on Windscale pile No. 2 are the amounts of radioactive iodine and strontium that can safely be allowed to escape. Of the two, the more difficult problem is that of the iodine which is released as a gas from irradiated uranium when it is oxidised. Much of this is likely to be adsorbed on to particles of matter in the cooling air or from parts of the reactor, but some may remain in gaseous form. It is clear that the Windscale filters can be improved. The efficiency of the improved filters would be such that, with the fission product detection gear working satisfactorily, any release of radioactivity from defective fuel elements that might occur on rare occasions during normal operation, would result in only a negligible discharge, well below the permissible amount. It is also clear that, with the improved filters, a small incident in pile No. 2 (one in which less than a complete channel of fuel was oxidised) could occur without the maximum permissible rate of discharge for a single event being exceeded.

On the other hand, if a major incident on the same scale as the fire in pile No. 1 were to happen, it could not be guaranteed that the filters, despite their improved efficiency, would restrict the discharge of activity to the levels allowable for a single incident.

Release of Wigner Energy From No. 2 Pile

A planned Wigner release from time to time has been used to get rid of the low-temperature component of the stored energy under controlled conditions, lest such a release be initiated accidentally by a rise in graphite temperatures. A number of methods of releasing the Wigner energy from pile No. 2 has been examined. Many had to be rejected entirely because they were impracticable. Four schemes merited closer study.

The Original Method.—The method used in the past was explained briefly in the report of the Committee of Inquiry (Cmnd. 302). Basically the procedure was to shut down the pile, modify the instruments, and then bring the pile back on to comparatively low power with no coolant flow. This " nuclear heating " raised the uranium and graphite temperatures ; because no coolant was flowing, the graphite temperature was greater than in normal conditions and, as a result, the Wigner release was started at some point in the graphite. The release would then propagate through the pile by transfer of heat from the hot regions where the release had occurred to the cooler adjacent graphite.

Several such releases of the low-temperature component in the Windscale piles have been made since 1952. The early ones were accomplished fairly easily, but it has become progressively more difficult to achieve a satisfactory result. The temperature necessary to initiate a release has risen, as also has the maximum temperature produced by the release. Moreover, there has been a growing tendency for the release to peter out, leaving regions of graphite unannealed. Such regions accumulate further Wigner energy by the time of the next release and can then develop higher temperatures. The difficulty of getting the release to spread has been partly due to the absence of thermal contact between neighbouring graphite blocks ; the blocks in the pile are separated by gaps to allow for the growth of the graphite under irradiation.§ Because of the difficulty of getting the release to spread through all the graphite of the pile, it has been necessary on certain occasions of Wigner release to apply a second nuclear heating sometime after the first. Even so, some parts of the graphite have remained unannealed.

During past releases temperatures of about 400 deg. Cent. have been reached ; in addition there have been pockets of graphite which have been left unannealed in previous releases in which higher temperatures have been recorded. In the light of remarks above on acceptable graphite and uranium temperatures, and in view of the fact that the application of a second nuclear heating in the absence of an air flow will entail uranium temperatures in excess of graphite temperatures, the original method is no longer acceptable.

The BEPO Release.—A release of Wigner energy by a new method was carried out on BEPO during March, 1958.

Electric heaters were installed in the air

§ At the Press Conference Dr. H. Kronberger, director of research and development in the Industrial Group of the Authority, said that it was feasible in future cores to have the blocks touching each other.

inlet ducts of the reactor; with these the temperature of the air blown through the reactor was raised to 140 deg. Cent. External heating thus replaced the nuclear heating which had on previous occasions been used in both BEPO and Windscale. The reactor was on low power throughout the release in order that the most sensitive apparatus for detecting cartridge failures (operating on short lived fission products) could be used.

After about twelve hours, during which the temperature of the air at the point of entry into the reactor had been raised to about 110 deg. Cent., the graphite on the front face of the reactor had reached about 90 deg. Cent. At this point the release began slowly. Heating was continued for a further few hours and as expected when the graphite temperature reached about 120 deg. Cent. the release became rapid; a rise in local graphite temperature of nearly 200 deg. Cent. occurred in the course of about fifteen minutes. The heat produced by the release in one block of graphite then initiated a release in adjacent blocks and the release spread fairly rapidly throughout the reactor; it had been completed throughout the pile within about twenty-four hours of the start of the operation. The maximum temperature recorded in the graphite was 316 deg. Cent. No fuel cartridges failed during the course of the operation. When the release was completed and all the temperature recorders showed falling graphite temperatures, the pile was blown cold and shut down.

In the BEPO release the maximum temperature recorded was well below 400 deg. Cent.; the condition of the graphite in the Windscale reactor, however, could be such that temperatures well in excess of 400 deg. Cent. would be reached. There is no reason to suppose that the existence of a comparatively small flow of air would substantially reduce the graphite temperatures below those that have been experienced during previous releases by the original method. To make an adequate survey of the state of the graphite in pile No. 2, as was done in BEPO and would be necessary before the possibility of adopting the BEPO method of release could be properly assessed, would require the examination of up to 5000 graphite samples taken from the walls of fuel channels. To obtain these samples would necessitate the removal of a large part of the uranium charge, which would be very costly. The examination of the samples, and the assessment of the results, would be a formidable task and might well only confirm that this method of release would not be practicable. It is most unlikely that, even if this method were eventually shown to be safe, it could be applied within a period of twelve months.

The Slow Heating Method.—In this method the aim is to release the Wigner energy gradually by slowly raising the temperature of the graphite to about 200 deg. Cent. by a flow of heated air. The rate of rise of graphite temperature must be sufficiently slow to permit a large part of the heat produced by the release to be removed at once by the air flow; the release will then not raise the temperature of the graphite seriously above that of the air. A comparatively small flow (about 4 per cent of full flow) of air would be sufficient provided that the temperature was raised gradually over a period of days. A guaranteed reserve of about 8 per cent of full flow would have to be available in case emergency cooling of the graphite became necessary. As in the case of the recent BEPO release the pile would be operated at low power to enable the sensitive fission product detection devices to be used.

A study was undertaken of the problems involved in supplying the necessary heat and in raising the temperature sufficiently slowly to a level at which a worthwhile release would take place. It was clear from the experiments done on the storage and release of Wigner energy in graphite that temperatures approaching 200 deg. Cent. would be required. On the other hand, it became apparent that an attempt to raise the temperature in the graphite to more than 120 deg Cent. would cause great difficulties. The long period of heating involved (several days) would cause unacceptable stresses in the concrete structure of the reactor. A temperature in the region of 120 deg. Cent. would be the maximum practicable, and on this basis the slow heating method would have to be repeated every two months.

Combination of Slow Heating Method and BEPO Release.—It appears possible to combine the two methods we have described in the preceding paragraphs to produce a satisfactory technique. The graphite temperature would first be raised slowly to 120 deg. Cent. by heating the ingoing air, and would be maintained at 120 deg. Cent. for about twelve hours; the pile would then be cooled down again to room temperature. This preliminary heating would remove some of the Wigner energy and reduce the maximum graphite temperature that might be reached in a subsequent self-sustaining release by about 80 deg. Cent.; the maximum graphite temperature would then be within acceptable limits. Second, the graphite temperature would be raised rapidly to about 160 deg. Cent. again by heating the ingoing air. This would bring about the release of the remaining low-temperature stored energy.

This method would certainly be effective, since all the graphite could be heated by hot air, and it would not be necessary to rely on transfer of heat from block to block to spread the release. The method appears to be practicable and the extent of the graphite sampling required is much less than that required if the BEPO technique alone were adopted. Since the period of heating in the second stage would be considerably shorter than would be required for the slow heating method, the problems of stresses in the concrete structure would be less severe. The provision and installation of the necessary equipment for heating the air would require six to nine months and the pile could be operational within about a year.

Operating Under Controlled Temperature

It would be possible to specify conditions which would make feasible the operation of the pile without further releases, this by controlling strictly the temperature of the graphite. Nowhere would the graphite temperature be allowed to rise by more than 20 deg. Cent. above its operating temperature except at a rate of less than 1 deg. Cent. per hour. This condition can be readily met as far as the bulk temperature of the graphite is concerned. It is, however, more difficult to guarantee the avoidance of any local rise of graphite temperature beyond the permitted amount. It would be impossible to install a sufficient number of thermocouples for this purpose. Special precautions would therefore have to be taken in the operational procedure to ensure that a rise of graphite temperature greater than 20 deg. Cent. could not be caused inadvertently through the movement of fuel elements, isotope cartridges or other means. As a further precaution an adequate guaranteed supply of cooling air would have to be available at all times to ensure that the graphite temperature would always fall at shut-down. While it would be possible to operate the pile safely in this manner, there would inevitably be a loss of flexibility in the loading and use of the pile. An added responsibility would be imposed on the operating staff at all times.

Main Conclusions

(i) Steps should be taken to prepare for the release of Wigner stored energy in Windscale pile No. 2 by the combination of the slow heating method and the BEPO technique.

(ii) This release should be carried out when the improved instruments and other modifications proposed have been installed; thereafter the reactor should be operated normally subject to the recommended modifications in procedure.

(iii) A possible alternative would be to operate the pile without planned releases under conditions applying strict control at all times to graphite temperatures, but this would restrict the flexibility of operation of the reactor, and the method suggested above is preferred.

(iv) The following modifications in Windscale pile No. 2 are recommended:

(*a*) A substantial increase in the number of instruments, particularly for measuring temperatures in the graphite and fuel. Apparatus for the detection of fuel element failures must be available at all times.

(*b*) The existing filters should be improved, even though this involves a higher pressure drop.‖

(*c*) The existing design of fuel cartridge is satisfactory, but the present design of lithium/magnesium cartridge is unsatisfactory. A full study must be made of the performance under all conceivable pile operating conditions of all materials used for the production of isotopes, for experimental purposes, &c., before they are inserted in the reactor.

(v) There is no need for a release of Wigner energy from the Calder Hall reactors for at least two years.

Motor-Cycling Survey

Ten thousand motor-cyclists whose names have been selected at random from the official records of motor-cycle registrations will shortly receive from the Central Office of Information a form on which they will be asked to answer voluntarily a number of questions, such as the type of machine used at the present time, how many miles the owner travelled during the last four weeks, if and when the owner first acquired a provisional licence, and what experience he has had of other types of machines. Names and addresses will be treated confidentially.

Answers to these and other questions will form part of a survey recommended by the Committee on Road Safety which Mr. Harold Watkinson, Minister of Transport and Civil Aviation, announced in the House of Commons last November that he had decided to put in hand.

The survey has the support of the Standing Joint Committee of the R.A.C., A.A., and R.S.A.C.

Previously, statistics on a "per mile" basis have been weakened by the assumption that the number of miles run per year by a certain kind of vehicle varies directly as the number of times such a vehicle is seen at a fixed check point, so that the miles per month information will have an obvious value. The other questions are presumably to elucidate the accident statistics, which show that in certain age groups accidents are more frequent, on a calendar basis, upon large-engined machines, which would be expected to have higher performance and better handling qualities; this cannot be completely explained by the higher annual mileage of such vehicles, because it is not true for all riders.

‖ At the Press Conference Dr. R. Spence, Chief Chemist, A.E.R.E., said that improved oiling was under investigation, and dry filters also; both wet and dry filters could perform better than hitherto.

Progress at Hunterston Nuclear Power Station

Approximately nine months after the construction of a nuclear power station was started at Hunterston on the Ayrshire coast, work is reported to be proceeding according to schedule and some of it, notably the excavation for the foundations of the second reactor, is said to be a few months ahead of programme. The "Goliath" crane is almost ready for its trials. The illustration right shows a late stage in its erection, when the 372-ton bridge was being lifted into position complete with its travelling 30-ton auxiliary slewing crane. We give below a brief report of progress in the construction of the station, which will have an installed capacity of 360MW and an ultimate net electrical output of 320MW.

READERS who compare the illustration on page 333 of our issue for February 28 with the photographs reproduced to-day will observe that considerable progress has been made in the construction of the nuclear power station at Hunterston, Ayrshire. It will be remembered that work was started late because of objections to the use of the site, but we gather that some of the lost time has been overhauled. The station is being built for the South of Scotland Electricity Board, whose territory covers about 8300 square miles and extends from the border northward to a line between the Tay and the southern shore of Loch Lomond.

The first reactor is to become critical early in 1961 and the second about a year later. When finished, the installed capacity of the Hunterston station will be 360MW, and in 1963 (the first full year of operation after commissioning), it will provide more than a quarter of the electrical power required in the south of Scotland. The installed capacity of nuclear plant in Scotland in 1963 will amount to 15 per cent of the total, if we include the Chapelcross plants. The corresponding proportion in the domain of the Central Electricity Generating Board will be 5·4 per cent.

The S.S.E.B. and the North of Scotland Hydroelectric Board are co-operating in the development of a 400MW pumped-storage scheme at Loch Awe. This is expected to reduce the cost from £150 per kilowatt for 300MW of nuclear plant to £85 per kilowatt for 700MW of combined nuclear and pumped-storage plant. Capital cost is saved at the expense of running cost, however, for the latter will go up by 50 per cent: this is because the efficiency of the pumping cycle is only 66 per cent. It is hoped that the pumped-storage scheme will permit the best use to be made both of Hunterston and of the new 760MW coal-fired station at Kincardine.

The nuclear station at Hunterston is being built by The General Electric Company, Ltd., in association with Simon-Carves, Ltd., Motherwell Bridge and Engineering Company, Ltd., and Mowlem (Scotland), Ltd. We give below a brief account of progress in the construction of the station, based on information provided by The General Electric Company, Ltd.

Civil Engineering

The foundations of the first reactor have been completed and two-shift work on the reinforced concrete superstructure is under way. The weight of the reactor, approximately 75,000 tons, is to be transmitted to bed-rock by a reinforced concrete raft 7ft 3in thick, cast in three lifts on mass concrete fill. The walls of the reactor building are now approaching the level of the charge-room roof, some 42ft above ground level, which will form the lower surface of the 6ft 6in thick concrete shield beneath the reactor pressure vessel. Charging and discharging of fuel will be by a single machine beneath the reactor.

The turbine hall, housing six 60MW turbo-alternators, will be approximately 700ft long and 130ft wide with a basement 12ft

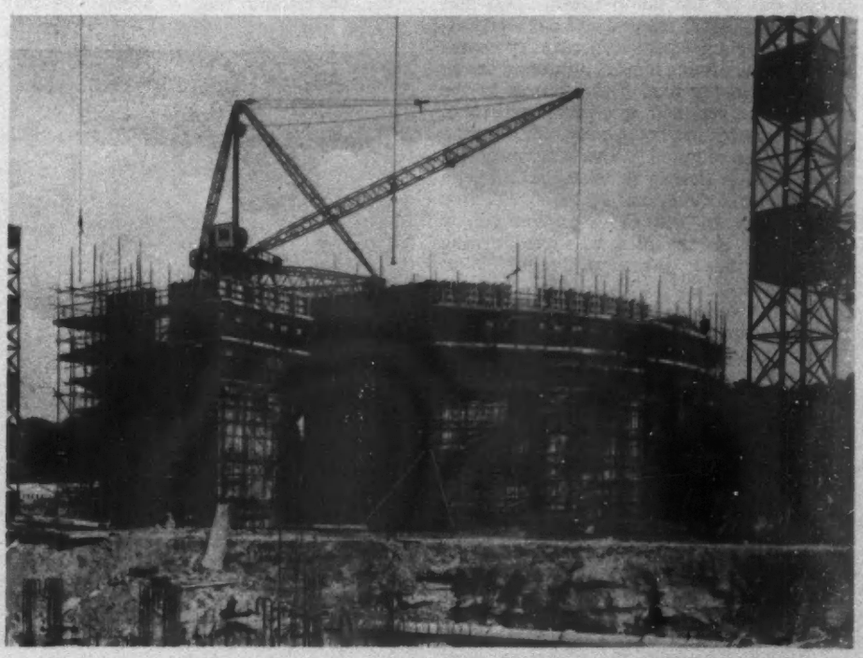


Fig. 1—The first reactor building in course of construction. The walls have reached the level of the roof of the shielded chamber in which the charge/discharge machine will operate beneath the reactor

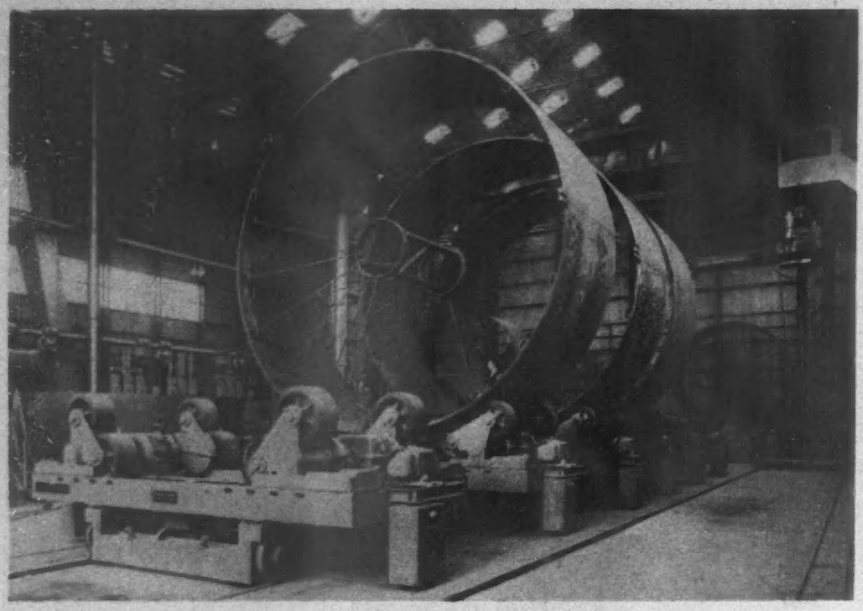


Fig. 2—One bay of the workshop in which the boiler shells are being fabricated

deep. Excavation of rock is here virtually finished, and mass concreting is well advanced. In addition, more than half of the reinforced concrete piers, which will be the foundations for the main stanchions, have been completed. Excavations for the circulating-water culverts running along the northern wall of the turbine hall are nearly finished, and the duplicate reinforced concrete inlet culverts are being made.

The circulating water system is designed for 324,000 gallons per minute, with an intake velocity of 1·5ft per second and a velocity of 5·5ft per second in the onshore intake culverts. The intake and outfall works will be of caisson construction, and will be connected by tunnels to the onshore works. Borings have been made on the lines of the inlet and outfall tunnels and at the caisson positions. About half-a-mile to the south-west of the main site, excavations are being carried out for the pump-house. This will house eight band screens and six vertical-spindle centrifugal pumps in two dry chambers with the driving motors at ground level.

The temporary road giving access to the site has been replaced by a permanent road, and other roads are being constructed on the site itself as required. The temporary 4in water main is shortly to be replaced by an 8in permanent main, and by the end of July the capacity of the site electrical supply system will be extended to meet growing power demands. The supply voltage is to be raised to 33kV, and a 10MVA transformer has been installed to step down to 11kV for primary distribution.

Welding

Welding of the shell for the first boiler was started at the end of March. This work is being done in a twin-bay workshop designed so that four of these cylindrical shells, each 80ft long and 20ft in diameter, can be assembled simultaneously. Most of the welding is done by two " Unionmelt " automatic machines, and complete radiographic examination of all welds is provided for. The workshop is served by two 40-ton travelling cranes, and a special furnace is being installed for relieving stresses in the completed shells.

Immediately outside the workshop, work is proceeding on the bottom crown and first course of the 70ft diameter spherical pressure vessel for the first reactor. Four " construction rings " are available. On one of them the bottom crown has been formed ; around it is being welded the cylindrical inner skirt which will carry the grid on which the core of the reactor is to be supported. On another ring the next tier of the vessel (the one to which the main supporting skirt will be welded) has been assembled for welding. Each of these two construction rings is in a portable steel enclosure to keep out the weather. On another part of the apron the " collector pan " (the circular steel plate on which the lower stand-pipes will terminate inside the pressure vessel) is being fabricated.

The so-called prefabrication apron covers the whole area between the boiler assembly building and the site of the second reactor. As well as the electrical supplies necessary for welding there is a propane installation for preheating.

We understand that a special welding school was established at Hunterston before fabrication began. By June over thirty welders, more than sufficient for current needs, had been approved, and others were still being trained. To ensure a continuing standard, all welders are tested from time to time.

Goliath Crane

The construction programme is based on a Goliath crane running on rails. This crane has a height and span of over 200ft. It can straddle the completed reactor buildings, and is to have a normal maximum lifting capacity of 300 tons. However, under special supervision it will be used for lifts of up to 350 tons, and will be tested for this duty. The major task in the erection of this crane, the lifting of the 372-ton bridge, was carried out on June 24. The 30-ton auxiliary slewing crane, which travels on rails on top of the bridge, was erected and tested before this and was lifted *in situ*. The highest point on the jib of the auxiliary crane that runs on the bridge is some 270ft above the ground.

The crane was designed to G.E.C. specification by Société Applevage, of Paris, the structure being supplied by them and the electrical components by the Witton works of G.E.C. It was erected by the Motherwell Bridge and Engineering Company, Ltd. The total weight of the crane itself is 1200 tons. Many of the major components were prefabricated in the manufacturer's works, and some 40,000 bolts, weighing about 30 tons, were used in the construction.

The principal data relating to the crane are as follows :—

Main Hoists

Two crabs, capable of lifting independently, or exactly together

Design load of each, tons	150
Main hoist motors, one for each hoist, horsepower, direct current	100
Maximum lifting speed (with 150-ton load), feet per minute	6
Cross-travel motors, one for each crab, horsepower, direct current	25
Maximum speed of cross travel, feet per minute	45
Long-travel motors, one for each pair of leg bogies, four altogether, horsepower, alternating current	45
Maximum speed of long travel (with 300-ton load), feet per minute	65
Bridge deflection with 300-ton load, inch	1

Auxiliary Fixed-Jib Slewing Crane

One 30-ton hook, one 5-ton hook

Common hoist motor, horsepower, direct current	100
Maximum lifting speed of 30-ton hoist, feet per minute	30
Maximum lifting speed of 5-ton hoist, feet per minute	180
Cross-travel motor, horsepower, direct current	25
Maximum speed of cross travel, feet per minute	100
Slewing motor, horsepower, direct current	25
Maximum rate of slew, revolutions per minute	1·5

Fig. 3—The bottom section of the 70ft diameter, 3in thick pressure vessel for the first reactor, formed ready for welding on the prefabrication apron at Hunterston

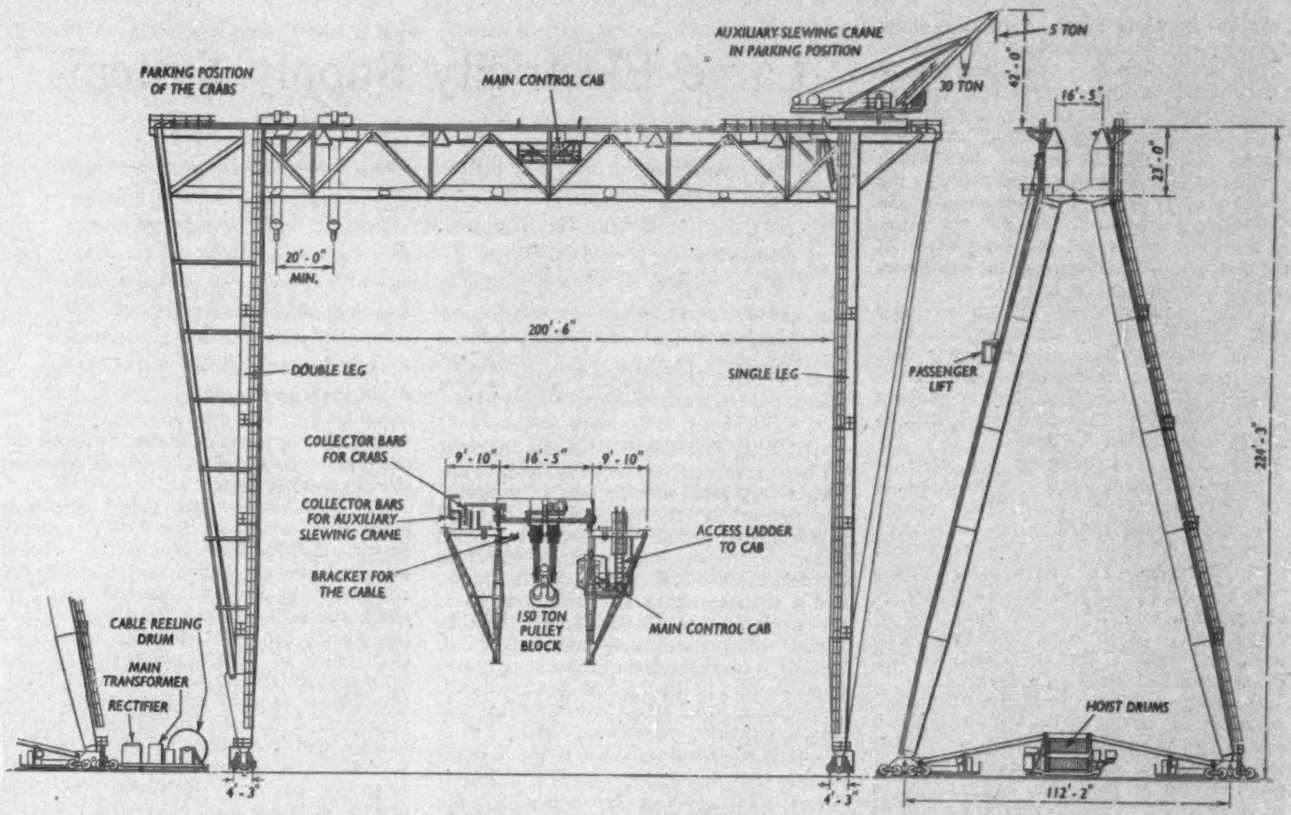


Fig. 4—Elevations of the 300-ton "Goliath" crane. A section at the centre of the main girder is also included

The crane is designed to work under wind pressure of 5 lb per square foot, and to withstand 60 lb per square foot when at rest in a storm. These loads correspond to wind speeds of some 30 and 100 m.p.h. respectively.

The bridge is formed from two triangular main girders, pin-jointed together at each end. Each girder consists of a box beam built up of riveted plates and rolled sections, with struts and diagonal members, and auxiliary girders to complete the triangular assembly.

The legs consist basically of four similar square-section columns, constructed from steel plate and rolled sections. The "double leg" is braced so as to withstand horizontal as well as vertical loads; the "single leg" is not braced, and takes only vertical loads. Each column is supported on two four-wheel bogies through an equalising beam, and each pair is tied at the bottom by a pin-jointed boom. The bogies have double-flanged wheels, with ball and roller bearings. Each of the inner bogies has all four wheels driven through spur and bevel gears. The crane runs on two pairs of parallel rails, 1000ft long, on either side of the reactor area.

Two hoist drums, machined and grooved, are mounted in the main leg ties on each side, supported also on bogies. The hoisting ropes pass up and over sheaves supported on the bridge structure, through sheaves on one of the two crabs and its associated hook, and to an equalising bar at the other end of the bridge. Both crabs are of welded construction, mounted on four double-flanged wheels with ball and roller bearings. They run on a common track, and have a parking area over the braced leg. The auxiliary crane runs on the same rails, and can be parked over the single leg. One or both crabs can be used together, or the auxiliary crane alone.

The sole power supplied to the crane is three-phase, 50 c/s a.c., at 415V, taken through a heavy three-core flexible cable which plugs into a socket near the mid-point of the track. The cable is wound on a reel mounted on a trolley attached to one of the main bogies.

Longitudinal drive of the whole crane is by four 45 h.p. a.c. motors, connected directly to the three-phase supply. All other motors are run from a 440V d.c. supply, obtained from a mercury-arc rectifier mounted on the same trolley as the reel. Also on the trolley is a lighting and heating transformer.

Control gear for the various motions has been located as closely as possible to the motors served. Where large differences of cable run remain between motors that require close matching of speeds, the impedance of the longer cable is simulated on the nearer motors. If signals from magslip transmitters on the main (idling) wheels indicate misalignment of the legs, the motors of the leading leg slow down, thereby keeping the alignment within allowable limits.

The main control cab is equipped with standard drum controllers for hoist and cross travel of the 150-ton crabs, and long

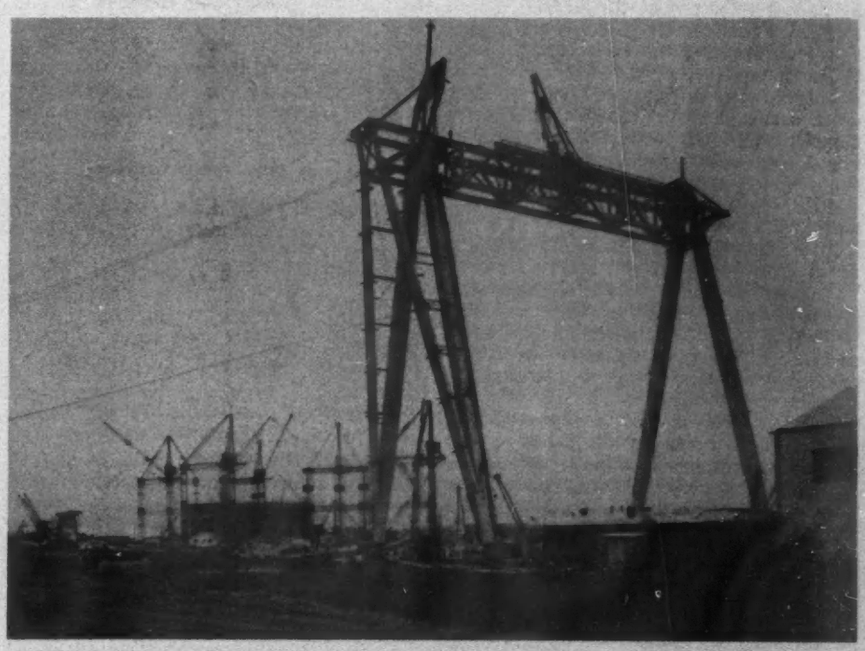


Fig. 5—A general view of the site, showing the 300-ton "Goliath" crane during the final stages of erection. On the left is the first reactor building in course of construction

travel of the whole crane. Indicators show the gross load on each hook.

The slewing crane is regulated from a chair having cam-controllers fitted in the arms. These govern the hoist, slew and cross travel, and long travel of the main crane. The dog-clutch and band-brake system for changeover from the 5-ton to the 30-ton hoist is operated from the rear of the slewing-crane platform. An inching button is conveniently located for engagement of the clutches. An indicator in the cab shows the load on the hook in use.

Communication between the crane driver and the slinger is by carrier-current telephone, working over the a.c. power line. The cabs have microphones and loud-speakers, and a telephone may be plugged into any point on the site power system to obtain contact with the driver.

The crane was designed for ease of erection and dismantling. Such parts as the leg columns and main bridge girders were partly prefabricated in the constructor's works and delivered in the form of sections about 40ft long. The first steps in erection were to join the sections of leg together on the ground, one column on each side of either track. At the same time the bogies, equalising beams, leg ties, and winding drums were assembled on the tracks.

When the first leg column was completed, including the beams at the top on to which the bridge would be joined, it was raised from the ground, using tackle slung from gin poles erected on each side, and fastened to trunnions fixed to the column just above its centre of gravity. As the ropes were wound in, the column assumed a nearly vertical position, its lower end being " tailed " by a mobile crane. Lifting tackle was arranged so that on completion of the lift the bottom end of the column was over its bogies ; it was then bolted into place and secured at the top by steel guy ropes. The second column of each leg was raised in a similar manner, and the hinge-pin inserted at the top. Erection of the two columns of the double leg followed.

The main hoists were used to raise the almost-completed bridge into its final position at the top of the legs, and the bridge was being built on the ground at the same time as the legs were being completed. Before raising it, the necessary temporary frameworks were installed at the top of the legs, the bracing struts of the double leg were raised and fastened into position, with their cross beams, and the auxiliary crane was completed and fully tested. With the bridge raised only a few inches above the ground, full tests were carried out on the main hoists, and the whole central span was slowly raised and then bolted into place.

As each section of the reactor pressure vessel is completed it will be lifted by the " Goliath " crane over the biological shield, which is being built at the same time, and welded in place. The heaviest lifts, for which special precautions will be necessary, will be of the core-supporting grids for each reactor, weighing 340 tons.

Boilers for the reactors are being welded in a special building on the further side of the prefabrication apron mentioned above. Each weighing some 210 tons, these will be lifted in their turn from a horizontal to a vertical position, using both main hoists of the crane, and carried to their places next to the reactor building.

Other heavy lifts will include those of the complete reactor servicing machine,* and precast concrete beams for the upper biological shield.

* A mobile pressure vessel installed over the upper biological shield: the machine is provided for maintenance of control rods, &c., while the reactor is working.

Large Electricity Supply Systems

No. V—(*Concluded from page 14, July 4*)

The seventeenth full session of the International Conference on large electricity supply systems which was held in Paris from June 4 to 14 was attended by delegates from forty countries. The subjects under discussion were : transformers, tele-transmissions, generators, circuit breakers, capacitors, high-voltage cables, system stability and control of load and frequency, insulating oils and materials, insulation co-ordination, reactive and distorting phenomena, protection and relays, voltages over 220kV, lightning and surges, telephone and radio interference. A résumé of some of the papers on a.c. voltages over 220kV and of some of the contributions to the discussion is given here.

SINCE the first 400kV overhead line went into service in Sweden in 1952, there has been a very rapid development of transmission systems at very high voltages in many parts of the world. For example, major systems are now operating at 380/420kV in Sweden, the U.S.S.R., Germany and France, and a similar voltage level will soon be in use in Finland. At the same time even higher voltages are being contemplated or actively studied for power transmission over long distances in the U.S.S.R. and Sweden.

In the U.S.A. and Canada 345kV and 360kV networks are growing rapidly and in Australia an extensive 330kV system is being

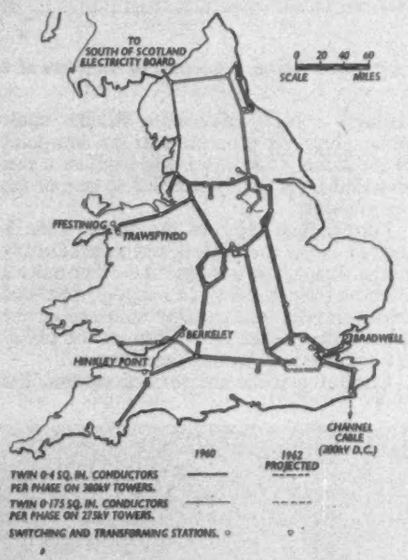


Fig. 1—275kV system development

built. In Great Britain and Japan the existing 275kV systems are being extended as planned.

Developments such as these were among the topics at a C.I.G.R.E. session (under the chairmanship of Mr. Philip Sporn, with Monsieur François Cahen acting as special reporter) devoted to extra high voltages.

Growth of Existing High Voltage Systems

In paper No. 413, P. W. Cash and A. Chorlton examined three aspects of main-transmission-system development in England and Wales. The first part of this paper reviewed the latest plans for the British 275kV scheme up to 1960, to provide adequate capacity of national interconnection, with facilities for bulk transmission from the central coalfields to the south and north-west of the country. It also gave an estimate of the requirements for 1961–65, allowing for the radically changing pattern of development caused by the nuclear power programme and by the trend towards greatly increased size of generator units.

As explained in the paper, the diagram (Fig. 1) shows the 275kV network now planned for 1960, together with certain projected later developments. Excluding the connection to Scotland but including four short sections to operate initially at 132kV, the scheme for 1960 comprises some 1700 route-miles of 275kV overhead line and forty-six substations, with a total 275/132kV transformer capacity of 13,500MVA. This represents a 50 per cent increase in line mileage and a doubling of the number of substations in comparison with the scheme originally envisaged for 1960, the main features of which were reported at the 1952 session of C.I.G.R.E. Two sizes of conductor are employed. The light-duty lines, used mostly in the north of the country, have twin 0·175 square inch conductors on each phase, giving a thermal rating of 375MVA per circuit. The heavy-duty lines, which comprise three-quarters of the total mileage for 1960 and are being adopted for all future lines in strategic positions, have twin 0·4 square inch conductors, giving a thermal rating of 570MVA per circuit, the towers being built with adequate clearances to allow the system to be converted to 380kV in the future, if required.

Table I shows the estimated maximum demands of the control areas (Fig. 2) in

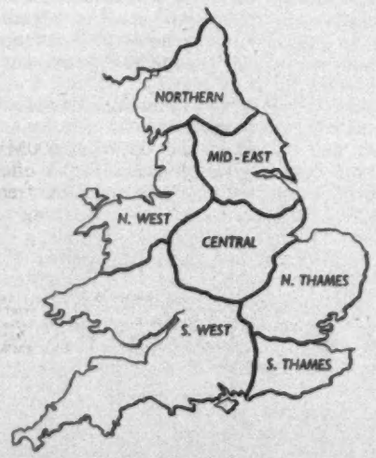


Fig. 2—Control-area boundaries, England and Wales

1960 and the planned transfers of power and energy between them. These transfers, which are designed to minimise the total cost of sending electrical energy from the pit-head to the consumer, result from the fact that much of the new generating plant has been allocated to the Central Area, where half the total coal required for electricity

generation in England and Wales is now produced.

TABLE I—*Estimated Maximum Demands and Inter-Area Power and Energy Transfers in* 1960

Control area	Maximum demand (MW)	Peak (MW)	Off peak		Net annual energy transfers (million kWh)
			Evening (MW)	Night (MW)	
Northern	1,400	+200	+200	+300	+3,000
North-western ...	3,970	−350	−200	−800	−5,000
North-eastern ...	2,730	+200	+400	+800	+5,000
Central	4,600	+700	+1,600	+1,400	+11,000
North Thames ...	3,250	−150	−900	−700	−5,000
South Thames ...	4,030	−400	−1,100	−600	−6,000
South-west ...	3,380	−200	0	−400	−3,000
Total	23,360	—	—	—	—

Taking account of oil-burning stations and the nuclear power programme, the estimated annual fuel consumption for electricity generation in England and Wales in millions of tons of coal or coal equivalent are as tabulated :

	1957–58	1960–61	1965–66
Coal and coke	43·5	46	44
Oil	1·5	8	6
Nuclear	Negligible	Negligible	15

It is planned to install between 1961 and 1965 a total of 11,500MW (sent out) of new generating plant, of which about 5000MW would be nuclear plant installed in ten new generating stations on coasts or estuaries in areas that are deficient in coal production, namely, North Thames and South Thames, South-West and North-West. Because these stations will have low fuel cost and will therefore operate at high load factor, they will tend to reduce the amount of energy which it will be economical to export from the Central Area.

Because these nuclear power stations are being sited away from population centres, it will be economic to connect them to the 275kV network rather than the 132kV network.

Statutory approval is being sought for locating the fourth* nuclear station (500MW sent out) at Trawsfynydd, North Wales, close to a 300MW pumped storage plant which is being built at Ffestiniog. These four nuclear stations can all be connected by relatively short lengths of line to the system already planned for 1960 but it is thought that the subsequent stations will need appreciable extensions of the 275kV network in the form of spurs or rings stretching to the east, south and west coasts.

Most of the new coal-burning stations to be installed from 1961 to 1965 will contain generators of 200MW, 300MW or 600MW capacity, for which switching at 275kV offers the only means of connection. A trend (Table II) towards 275kV switching of generator plant is, thus, displacing the trend towards 132kV switching which has been strongly in evidence since 1950.

TABLE II—*Installed Capacity of Generators at Various Switching Voltages*

Switching voltage	Plant in service		New plant to be installed		Total plant in service 1965[1] (MW)
	1950 (MW)	1955 (MW)	1956–60 (MW)	1961–65[2] (MW)	
Below 132kV ...	12,378	15,037	1,415	170	13,522[1]
132kV ...	1,019	5,429	5,833	3,060	14,372
275kV ...	—	—	1,680	9,200	10,880
Totals	13,397	20,466	8,978	12,430	38,774[2]

[1] Provisional.
[2] Allows for withdrawal of about 3100MW of old plant by 1965.

* The other three stations mentioned in paper No. 413 are Berkeley, Bradwell and Hinkley Point. It will be recalled that application has also been made for consent to develop a site at Dungeness for a fifth nuclear power station. It would have an output capacity of 500–550MW and would be connected to the 275kV transmission system which (as shown in Fig. 1) would be connected at Lydd, via the projected cross-channel cable, with the French electricity system.

Nuclear power developments will not give rise to any major modification of the Swedish power transmission system as explained in paper No. 413 by Geijer, Jancke and Holmgren. The reason is that about 85 per cent of Sweden's water power resources are situated in the north while about 85 per cent of the population (and, therefore, most of the load) is in the south. Accordingly large quantities of energy must be transmitted over long distances from the north to the load centres in the south. Nuclear power stations will probably be built in the south to supply part, at least, of the base load, but even then, the future maximum demand for power transmission from north to south is estimated at 8000MW to 10,000MW.

The first sections of a 400kV network went into service in 1952 and by 1958 this e.h.v. network will include a total length of 3100km of overhead line and a connected transformer capacity of 7600MVA. The longest section of this network is 1350km.

Raising Working Voltage on Existing Systems

Allowing for further growth in Sweden's power demand paper No. 414 also looked into the technical and economic possibilities of raising the voltage on the existing system, compared with the superimposition of a new system at a higher voltage. To find a basis for comparison the Swedish State Power Board initiated a fresh study of system voltages as briefly mentioned at the 1956 C.I.G.R.E. session. The main alternatives considered were 400kV, 500kV and 650kV alternating current and ±400kV direct current. It transpired that although transmission would be cheapest at 650kV the gain, compared with the continued use of 450kV, would be marginal and would not justify the complications and risks involved in introducing a new system.

Instead, it was decided to go on extending the 400kV network and to equip the major new lines with three conductors per phase, each conductor of 31·7mm diameter and 593 square millimetres cross section (a.c.s.r.) in place of the two conductors of the same size, as used for the earlier lines. Some of the latter will subsequently be converted to three conductors per phase and, like the new lines, will then be suitable for operation at 500kV, since the demand for insulation will decrease progressively as the short-circuit power connected to the network increases, and since radio interference will raise no new problems at the higher voltage. The operating voltage of certain lines will then be raised by auto-transformers as required.

An empirical working rule has been established whereby transmission can be regarded as being dynamically stable for all line faults provided that the static stability limit is not exceeded when one line is taken out of service. Accordingly the load per line can be raised when the number of lines is increased. It has been found that the most economic load per single line at 400kV is 600MW with twin conductors and 800MW with three conductors per phase. At 500kV the economic load becomes 1000MW.

Three other papers dealt with the problems of increasing the working voltage on existing high-voltage systems. For example, paper No. 415 by Ailleret and Caillez described a conversion scheme, sections of which have already been completed. The system in question was the 225kV line between the Massif Central and Paris. This line was originally commissioned ten years ago with two 225kV circuits but was designed for simple conversion to 380kV when required. The six conductors of the 225kV circuits were carried on the horizontal cross-arm of a lattice tower at a spacing of 6m between adjacent conductors of the same phase and 9m between phases. In the final conversion bundles of two conductors were formed by regrouping the original six conductors in three pairs, and these three bundle conductors were suspended each from a V-shaped double string of insulators. The two strings making up each " V " were supported from the original points 6m apart on the cross-arm and the final spacing between the three conductor bundles is 15m.

Paper No. 407, by J. W. Simpson and V. E. Ogorodnikov, described how a Canadian line strung on wooden poles was converted from 115kV to 230kV. This change-over involved an increase in line insulation by the addition of two insulator units to each string. At a few places on the route it was necessary to increase clearances. By accepting some increase in radio interference levels and some loss of service reliability it was possible to use the existing conductors at the higher voltage. In the event, during twenty months of operation (sometimes at voltages up to 262kV) switching surges have not caused any insulation failures. Only three sustained outages are reported to have occurred : two were the result of cross-arm burning because of excessive leakage currents and the third was caused by lightning shattering an insulator.

In paper No. 410, A. A. Akopjan *et al* gave test results and operating experience with the 400kV transmission system between Kuibishev and Moscow, and examined the development of 400kV to 500kV systems in the U.S.S.R. between 1960 and 1965. On the Moscow–Kuibishev line one circuit has been in operation since May, 1956, and the second since December, 1956. At that time, twelve generators were in service in the Kuibishev station and by October, 1957, all the twenty sets were operating. In the first year of operation 3320 million kWh were transmitted over the line and since then the transmission system has been functioning mainly under base load conditions.

Field experience and other tests confirmed the theory that it would be necessary to use shunt reactors as parallel compensation for this 400kV line. On-load tap-changing at 400kV also proved to be necessary and the full range of ±12½ per cent of taps is used. For the first stage of operation, when there was a preponderance of reactive power over the line, the voltage was limited to 370kV to 380kV. As more generators came into service, however, and the active power transmitted rose, the voltage was raised to its rated level and later to its maximum value of 420kV. Tests suggested that it should be possible to raise this voltage further and now a maximum continuous voltage of 440kV is permitted on this system.

On the basis of field experience with this line, together with other research studies, it is concluded that the clearances and insulation of the existing line are such that the voltage could be raised to 500kV provided that the internal over-voltage limit be reduced from 3 to 2·5 times the rated phase voltage. With the existing geometry of a bundle of three conductors per phase it is considered that the radio interference noise level and the corona losses will still be tolerable at 500kV. It is stated that comparatively little work will be involved in rebuilding the transformers and other equipment for 500kV. In March, 1957, a 75km section of the line, together with part of the Noginsk substation were

worked at 500kV for three days during which tests were satisfactorily carried out.

As a result, it has been decided to design all new long-distance transmission systems (coming into service from 1959 onwards) to operate at 500kV. The existing Kuibishev–Moscow line and other lines due to be commissioned in this year will operate initially at 400kV and will then be modified for conversion to 500kV. A typical tower is illustrated in Fig. 3.

A comparison between the economics of the 400kV and 500kV systems is outlined in the paper; it states that the higher voltage increases the transmission capacity by 40 per cent or allows for a corresponding decrease in cost because of the saving in equipment for increasing system stability. If the basis of comparison is the transmission of 650MW to 700MW over a distance of about 800km to 1000km, then, by raising the line voltage from 400kV to 500kV the first costs will be reduced by 3 to 5 per cent and the running costs of power transmission by 4 to 9 per cent.

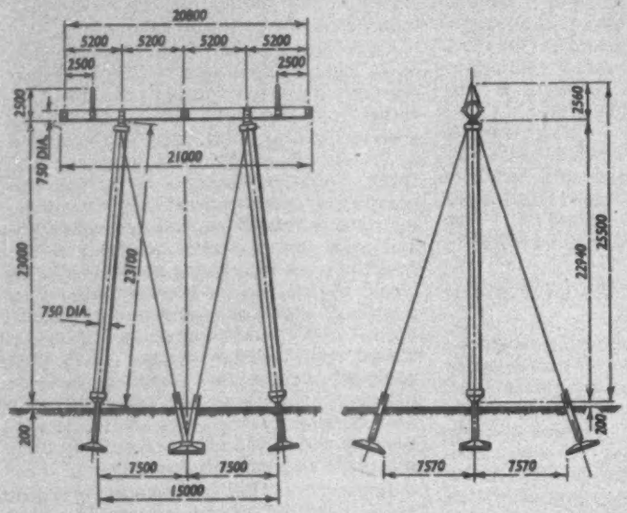


Fig. 3—Suspension tower made of precast reinforced concrete for 500kV line

Power Transmission Over Very Long Distances

For transmitting power economically over very long distances, as envisaged within the U.S.S.R. in the near future, still higher voltages will be required, and the developments described in the previous section were taken a stage further in paper No. 411 by N. B. Bogdanova *et al*. This paper gave details of studies aimed at determining a new voltage level for transmitting blocks of power of the order of 4000MW over distances of 1500km to 2500km. Power exports of this order may well be common between Siberia and the Urals within the next fifteen years. For these potential requirements the possibilities of direct current as well as alternating current are being studied, but paper No. 411 dealt with the a.c. work only.

Compensation of the system parameters, as pointed out in the paper, is absolutely necessary for transmission lines of the length and capacity under consideration. As the length of line approaches 1500km (which, at 50 c/s, is one-quarter of a wavelength if the line is uncompensated) special factors arise which make compensation essential. For example the voltage changes sharply whenever the power demand changes; the voltage distribution along the line may be incompatible with certain operating conditions; the stability is poor and the power losses are too high. Compensation is effected by synchronous condensers and series capacitors distributed fairly evenly along the line to reduce the effective wavelength.

A comparative study based on a phase bundle of four conductors, spaced 50cm apart, shows that the initial cost of a 400kV, single-circuit line to transmit 750MW over 2000km is 1500 roubles per kilowatt. By raising the voltage to 600kV and raising the transmitted power to 1500MW to 2000MW, the specific initial cost (that is, capital cost per kilowatt) would be reduced by about 35 per cent. For the same power transmission, however, it is considered that an increase of voltage from 600kV to 700kV would not lower the capital costs appreciably. Accordingly, for future design studies with alternating current, operating voltages of 660kV (maximum) and 600kV (rated) were adopted.

In their work on the withstand strength of large air gaps the authors found the breakdown voltages for rod-rod and rod-plane configuration to be very different at voltages above 1000kV, r.m.s. Accordingly, they decided that the withstand strengths of standard air gaps should not be used in determining the dimensions of transmission lines and switchgear equipment at voltages above 400kV. Specific information on breakdown voltages for actual electrode configurations is required.

As already indicated, present work at 600kV is based on the use of four standard conductors (each 37mm diameter) in a phase bundle. If the conductor diameter be increased by 20 per cent only three conductors would be required, but the technical and economic aspects of these alternatives require further study.

Internal Over-Voltages

Internal over-voltages provided topics common to many of the papers under discussion. According to present-day thinking, the insulation of lines and equipment is determined by the internal over-voltage level of the system rather than by external over-voltages. At extra-high voltages flashovers on line insulators caused by lightning are rare; automatic reclosing ameliorates the effect of most of these over-voltages; and consequently line insulation should be conditioned only by the internal over-voltage withstand value.

Support for this theory is forthcoming from many tests made on the 400kV Kuibishev–Moscow lines from which it is concluded (paper No. 410) that a maximum over-voltage factor of 2·5 is adequate to cover all contingencies. The advantage can be exploited either by operating existing lines at a higher voltage or by reducing the insulation of future lines for 400kV. In the U.S.S.R. it has been decided to raise the main system voltage from 400kV to 500kV: no modifications are required on the line itself, and, although the transformation ratio of the equipment will have to be altered, no change will be required in the impulse withstand level of 1500kV.

Comprehensive studies have been made in Sweden, with the help of a transient network analyser. Two interesting points emerge. One is that in long transmission lines the internal over-voltages are likely to be higher at the ends of the line than at the stations. In effect, therefore, the lines may be over-insulated compared with the station equipment, and, on very long lines, the ends may be over-insulated compared with the central sections. The second point is that a decrease in the system impedance has a very favourable influence on the internal over-voltage level. It follows that, as a system grows, the over-voltage level falls and the insulation of the equipment can be reduced.

With the Swedish 400kV system (maximum voltage 420kV) it is now considered that, for sections of line less than about 550km long, it is possible to work with an impulse level of 1425kV on the station equipment and 1300kV on the line (paper No. 414).

In France (paper No. 415), as a result of work done with the help of a micro-network-analyser, the insulation characteristics of the 400kV system have been established.

The impulse withstand level is 1450kV for the transformers and 1650kV for the other items of station equipment and line insulator strings. It is expected that as the power capacity of the system grows it will be possible to reduce the levels quoted above.

Corona Effects

Corona Losses.—The papers under discussion showed that the problems of corona losses were solved by using conductor bundles. According to paper No. 401, by Glöyer and Vogelsang, corona losses are insignificant on the German 380kV system with a bundle of four 21·7mm conductors. Results obtained from a testing station indicate that the average annual three-phase losses would be about 1·5kW per kilometre, which is 2 per cent of the I^2R losses; in dry weather, the corresponding figure would be only 0·6kW per kilometre.

Measurements made in Sweden on an experimental line and on the actual 400kV lines (paper No. 414 by Geijer, Jancke and Holmgren) gave average values of three-phase annual losses of 3·5kW per kilometre (wet) and 0·6kW per kilometre (dry) with a bundle of two 31·7mm conductors. With three bundled conductors the same losses, quoted above, are obtained at 500kV, while the losses at 400kV are halved. In the technical and economic studies of the extra high voltages contemplated for long-distance transmissions in the U.S.S.R. (paper No. 411, by Bogdanova *et al*), it is proposed to take account of corona losses. Accordingly, for a working voltage of 600kV the choice would probably lie between a bundle of four 37mm conductors or one of three 44mm conductors.

Radio Interference.—In most instances, with the exception of high-voltage transmission across thinly populated areas, radio interference is more troublesome than the losses associated with corona. Paper 401 showed that the German 380kV lines with four-conductor bundles gave greatly reduced radio interference levels of 180μV per metre at 1000 kc/s and 310μV per metre at 200 kc/s. Paper No. 409 (Germany) showed that a two-conductor bundle has three times the interference level of a single 42mm conductor in dry weather. Paper No. 410 (U.S.S.R.) suggested that the lines with three-conductor bundles operating at a maximum voltage of 440kV have a radio interference level comparable with that of the 220kV single-conductor lines. In Canada the conversion of a line from 115kV to 250kV (paper No. 309) without modifying the conductors has considerably increased the level of radio interference.

Influence of Altitude on Radio Interference.—Paper No. 405 (U.S.A.) described tests carried out with an experimental line at Leadville in the Rocky Mountains at an altitude of more than 3000m ; experiments were made on a single 42mm conductor, a bundle of two 23·4mm conductors, and (for a short time) on a four 35·5mm conductor bundle. The results are to be compared with those previously obtained at the Tidd station at an altitude of 200m ; it is too early, as yet, to draw conclusions, but it may be deduced, however, that for the bundle the threshold voltage is about 23 per cent higher at Leadville than at Tidd. The ratio of the air densities is approximately 1·35. This fact seems to confirm Peterson's law, which states that the threshold voltage varies according to the power 2/3 of the relative air density.

Paper No. 408 by R. Bartenstein (Germany) and de Stadelhofen (Switzerland) gave an account of tests carried out under the 220kV line laid across the Gothard ; radio interference measurements were made at two points at altitudes of 2095m and 260m respectively. They gave the following results: first, at the same voltage, the general level of the interference spectrum increases, in dry weather, by 6 dB (0·33 dB per 100m) ; secondly, at a given point, the disturbing field increases in dry weather by 1·25 dB per 10kV of voltage increase ; thirdly, in the rain, the disturbing field increases at the most by 15 dB ; fourthly, the measured increase of the interference level is justified, if it is accepted, according to Paschen's law, that the air break down gradient is proportional to its relative density.

Predetermination of Radio Interference.—Paper No. 409 by Bartenstein (Germany) gave the results of longitudinal attenuation interference measurements carried out on sections of different lengths of four conductor bundle lines. Results at 100 kc/s were : a 2·8kW per kilometre attenuation constant for symmetrical propagation (between conductors) and 60kW per kilometre for asymmetrical propagation (between conductor and earth). Transversely, the disturbing field is attenuated by 30 dB at a distance of 100m from the outer conductor of the line.

This paper also suggested a method for predetermining the interference level generated by an industrial line provided with a given equipment by the extrapolation of measurements carried out under a single-phase test line with the same equipment, but very short in length (100m for instance). This test line must be closed at both ends on its surge impedance through a coupling capacitor to avoid reflections on the ends. The factor to be applied to the measured level at a given frequency is given by a simple formula incorporating the asymmetrical longitudinal attenuation coefficient and the test line length.

For instance, on changing from a 100m long single-phase line to a two-circuit, three-phase line, longer than 8km, an increase of 26 dB results ; as the spectrum is uniform it is sufficient to make measurements at two frequencies.

Paper No. 405 by Robertson and Wagner (U.S.A.) propounded a theory of the radio interference phenomenon upon which is based a method of predetermination for the level of this interference near a line with a given equipment. The proposed formula includes the three following terms :

1. The "excitation" which is an overall characterisation of the currents generated in a line from the surface discharges due to corona : for a line conductor the excitation depends on the intensity and distribution of the electric field along its periphery and on the surface condition. The total excitation is the quadratic mean of the excitations of each of the conductors in each phase.

2. The "attenuation factor" which depends on the longitudinal attenuation of the line.

3. The "field factor" which depends only on the line geometrical characteristics, and on the distance between the line and the point at which the measurements are made.

As an example for the application of this method, the paper gave curves showing the value of the minimum conductor diameters to be used in practice with an equipment of one, two, three or four conductors per phase as a function of the working voltage of a system between 200kV and 600kV.

Discussion

F. J. Lane (Preece Cardew and Rider, Great Britain) spoke of the growing emphasis that civilised communities put upon the preservation of amenities. In Great Britain in particular, strong pressure was being brought against the obtrusion of transmission lines and other engineering works on the rural scene. One way of conforming to public opinion was to exploit existing wayleaves to the full and that was being done in Great Britain by using double circuit 275kV transmission wherever possible. Like many other delegates he had been impressed by the technical excellence of the Plessis–Gassot 380kV substation, but the forest of transmission towers and overhead lines covering acres of the countryside would have aroused a storm of protest if they had been set up anywhere in Great Britain. The only alternative to overhead lines was the underground cable, but the ratio of the costs of these two methods was about 1 : 16 and before the cable could be economically competitive there was need for serious study of methods of reducing costs, for example, by high-voltage d.c. cable.

Overhead lines found a champion in Mr. Philip Sporn (U.S.A.) who spoke in the discussion as a private individual and not as chairman of the session. He pointed out that a strong argument for the use of extra-high-voltage transmission was that it made the minimum demands in the way of intrusion on private property. Engineers should not capitulate but should concentrate their efforts on designing and building towers having symmetrical lines and pleasing appearance. If the Eiffel tower were used as a model transmission-line towers need not be ugly.

G. G. Smail (South of Scotland Electricity Board) outlined the course of developments at 275kV in the South of Scotland. A scheme had been approved for superimposing a 275kV system on the existing 132kV network. In its first stage this scheme would provide for a 150-mile ring linking Glasgow and Edinburgh by two routes by 1965. Links with the 132kV system would be provided probably at five points by 275/132kV auto-transformers and there would be a link with the North of Scotland Hydro-Electric Board's system by an existing 275kV line.

Load in the south of Scotland was growing at an annual rate of 6 per cent. Among the provisions to meet this demand was the nuclear power station at Hunterston and the coal-burning station at Kincardine which was due to contribute 376MW of new capacity by 1964. In addition there would be the 400MW pumped storage scheme at Loch Awe. As far as could be seen up to 1975, no advantage would be gained by changing from 275kV to 380kV.

W. Casson (Central Electricity Generating Board) spoke of the growing difficulties of obtaining transmission line wayleaves and substation sites in Great Britain. Because of these difficulties, he thought that one should consider the uprating of existing lines, from 132kV to 275kV and from 275kV to 380kV. By converting a double-circuit 132kV line into a single-circuit 275kV line, the transmission capacity would be doubled. Likewise, conversion from 275kV to 380kV would give a 50 per cent increase in capacity. According to paper No. 407, the cost of uprating an American 115kV line to 230kV was low. There was, in fact, a saving of nearly 1000 dollars per mile compared with the cost of building a new 230kV line.

Lalander (Sweden) said that in his country the best sites for hydro-electric stations would have been exploited within ten or fifteen years. He visualised the need for nuclear power stations with large outputs (1000MW or more, each) transmitting power over distances of 100km to 150km, and the existing 400kV system would be quite adequate for such conditions. Commenting on paper No. 413, Lalander said that it was expensive to transmit reactive power and that it was better to generate it near the load ; it was interesting to see that Great Britain seemed to be moving towards Swedish practice.

G. Jancke (Sweden) said that on the earlier 380kV Swedish lines impulse withstand voltages of 1550–1600kV had been adopted, but that on the more recent lines these conservative figures had been reduced to 1275kV. It appeared, however, that, more recently still, French and German engineers had chosen values of 1650–1750kV. What were the reasons for such values of line insulation ?

Some particulars were given by P. Sporn (U.S.A.) of the recently announced decision to build and operate in the U.S.A. a 7½km transmission line for experimental work at 460–750kV, at a cost of 5,500,000 dollars. This project is being undertaken by the International General Electric Company of New York in collaboration with the Western Massachusetts Electric Company, which will eventually take over the line for operation as part of its e.h.v. transmission system.

Some results of corona loss measurements on the experimental overhead transmission line at Leatherhead were given by J. E. Forrest (Central Electricity Research Laboratories, Great Britain). It was operated as a single-phase line, the stress on the twin 28·6mm conductor being such as to make the operating voltage equivalent to 380kV. The power loss measured in rain was 140kW per three-phase mile, the energy loss per annum being 60,000kWh. It was found that the grease applied to the conductor to prevent corrosion resulted in an increase in radio noise.

Magnifier with Shadowless Cold Illumination—We are informed by Optical-Mechanical (Instruments), Ltd., 17, Station Road, Egham, Surrey, that this company has acquired the sole agency for the Swiss "Frigolux" magnifier, which provides shadowless illumination in cold light. The lens is 3·5in in diameter and has a magnification of 2 : a smaller lens can be superimposed to increase the magnification so that parts of the object under inspection can be seen enlarged six, nine and fourteen times. The cold-light tube is claimed to provide almost the equivalent of daylight, permitting very precise discrimination of colours. The light source is reported to have a life of about 10,000 hours, regardless of the number of times it is switched on and off. The instrument weighs about 8 lb, is about 30in long and 15in high. The lens is mounted on a beam clamped to a vertical shaft, the latter being screwed into a heavy disc forming the base. The 110/125/220V transformer is placed opposite the lens on the other end of the beam, acting as a counterweight.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

INDUSTRY FIGHTS CORROSION

SIR,—In your issue of May 30 you publish an abstract of my paper "Protection of Plant and Equipment in Petroleum and Chemical Industries," which includes the statement that "for pipelines coal-tar pitch is favoured for external protection."

It is appreciated that your abstract was necessarily very compressed but the sentence quoted does not convey the correct impression. The following quotations from the section of the paper dealing with the external protection of buried and submarine pipelines give the correct picture regarding heavy coatings for such lines :

"Although many types of protectives have been tried, the great majority of buried and submarine lines, including lines recently installed, are protected with coal-tar pitch or bitumen which is usually filled with 25 to 30 per cent by weight of an inert filler such as talc, slate, &c.

"In Europe the normal practice is to use bitumen coatings, whilst in the U.S.A. coal-tar pitch has been favoured, although a number of companies are now changing to filled blown bitumen coatings."

London, E.C.3, H. B. FOOTNER
July 1, 1958.

A "TIDDLEY" BUDGET

SIR,—Mr. Jellett seems to recognise that the subject of income tax and subscriptions to professional institutions has been a burning question for a number of years, and yet fails to make fairly obvious deductions from that fact. It follows from this that a very large number of professional institutions, together with organisations such as the Institution of Professional Civil Servants, have carried out a campaign over a series of years. Mr. Jellett does not seem to realise that what has happened in previous years has been a part of the build-up which has led to the success of 1958. As long ago as the period of the Labour Government, while Mr. W. G. Hall was the Financial Secretary to the Treasury, he made an exhaustive statement on this issue during the discussion on the Finance Bill of the year, and set out in considerable detail the official line against the concession for which all of us were asking. Undeterred by the defeat of that year, we all of us went on each year returning to the charge and seeking to get the matter ventilated during the debates on the Finance Bill. This happened again in 1957. As a preliminary to the introduction to the Budget there were very many representations made to the Chancellor of the Exchequer. When the issue was raised once again on the floor of the House, the then Chancellor of the Exchequer, recognising the weight of these continued representations, promised that during the year 1957–58 he would give the matter very close and careful consideration.

During the Financial Year 1957–58, every organisation with an interest in this area, or, perhaps, I had better say each one with which I am acquainted, made representations to the Chancellor of the Exchequer. Some of them were made directly, some of them were made indirectly, some were made in association with other bodies, some of them were made by the individual organisation. The Institution of Professional Civil Servants, for example, made representations to the Treasury as the employer of many thousands of professional and technical workers interested in this issue, and, also, made direct representations on its own to the Inland Revenue Department. While it was making these representations on its own it was well aware of what other people were doing and, indeed, was keeping in close consultation with a number of other organisations on this issue throughout.

Mr. Jellett may well like to hug to himself the idea that it was his blast on the trumpet that brought down the Walls of Jericho. I am afraid that it is the experience of the rest of us that life is much more prosaic than that.

STANLEY MAYNE,
General Secretary.
Institution of Professional Civil Servants,
28, Broadway, London, S.W.1,
July 1, 1958.

[As it seems to us the parties to this discussion have fully made their points, no further correspondence on the subject will be published.—ED., THE E.]

Book Reviews

Technology of Instrumentation. By ERIC B. PEARSON, M.Sc., F.Inst.P., A.M.I.E.E. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 25s.

IN the last ten years very many books have been written on what might be described in broad terminology as instrumentation. This includes such subjects as servomechanisms and control engineering, so that the appearance of yet another book requires some initial justification. The author aims this particular book at the undergraduate or the person who wants to approach the subject of instrumentation with caution, and indicates that the majority of previously published books are for the expert engineer and scientist. To this end a broad field is covered in a general fashion: as a description of what is involved in "instrument technology," leaving the necessary working detail for subsequent study, this book is considered to fulfil its primary object.

The book opens with a discussion of the basic principles of measuring instruments crystallising some rather fundamental, but nevertheless important, rules, such as the relationship between accuracy demanded and instrument cost and also the necessity for checking instruments for accuracy at regular intervals. The second chapter discusses the characteristics of instruments with moving components and shows how the instrument response can be obtained. This involves a very elementary discussion of the characteristics of simple vibrations and shows how various damping characteristics can be built into the instrument. Static accuracy is discussed, and the third chapter goes on to the question of dynamic accuracy or accuracy in the transient condition. Responses to various forms of input are considered and this chapter again is based on the solution under various conditions of simple second order differential equations. The fourth chapter discusses laboratory techniques for the measurement of response characteristics, such as the inertia of the moving instrument parts or the viscous damping to which they are subjected. It also emphasises that care must be exercised in the basic assumptions with regard to instrument behaviour as it is not always valid to neglect the non-linearities involved and this is precisely what has been done in the earlier analysis.

The next chapter goes on to the subject of the application of instrumentation to process control and shows the necessity for accurate measurement of the system characteristics before accurate control can be carried out. The feedback principle is introduced and it is shown how this can be used to maintain a process at a given level, deviations from this level being signalled back to cause a change in the input requirement. Automatic position control is taken as an example and the basic theory given. Having introduced the subject of servomechanisms a major chapter is devoted to a discussion of means of improving their performance. This is presented in a very elementary form. One worthwhile feature, however, is the frequent focusing of attention on the limits of the theory being discussed, and the extent to which it is capable of development by more advanced mathematical techniques. A book of this kind would not be complete without an excursion into the field of system stability. In this case it is a condensed form of what is usually found in books on servomechanisms and the usual concepts of Routh and Nyquist are introduced, as well as the widely accepted servo terminology for describing control systems.

Going on from here, a chapter is devoted to a description of components used in servomechanism layouts and the various factors which are considered in the design of a control system. Various comparison elements are sketched. A discussion is given on the various kinds of servo amplifiers available, including mechanical, electrical, magnetic, electronic, hydraulic and pneumatic, but it involves, as might be expected, no more than a very cursory and elementary glance at the characteristics of the various types.

The final chapter discusses a subject which is not often found in books of this particular kind and is headed "Instrumentation of Mathematics." This introduces the science of computing and as such, of course, involves instrumentation and measurement of a very fundamental nature. We could quibble with some of the statements on accuracy of computing devices and also with the choice of instruments illustrated and described, but the chapter is useful in indicating that in the computing field there is at present one of the best outlets for undergraduates interested in the technology of instrumentation.

This book is fundamentally a summary and introduction to the subject of instrumentation and as such does not have any pretension to detailed or profound analysis. It would appear to be quite useful for undergraduate reading or for any person who wants a simple introduction to the subject.

L'Année Ferroviaire, 1958. By CHARLES BOYAUX, SEVERO RISSONE and MAURICE DE VOS, and the SERVICES TECHNIQUES DE LA S.N.C.F. With a foreword by Louis Armand. Paris: Librairie Plon, les petits-fils de Plon et Nourrit, Imprimeurs-Editeurs, 8, rue Garancière, Paris (6e). Price: Fr.840

THE twelfth edition of *L'Année Ferroviaire* appears this year, the year of the Brussels World Exhibition. Accordingly, the first part of the year book is devoted to issues touched upon by the exhibits at Brussels of the International Union of Railways (U.I.C.). Three articles contributed to the volume by Messieurs Boyaux, Rissone and de Vos, general managers, respectively, of the French, Italian and Belgian railways, discuss the technical state of present-day European railways, their importance to society, and their development since the war. The second part deals with traffic statistics collected by the U.I.C., chiefly up to and including 1956, while other chapters are devoted to the traffic and technical developments of the S.N.C.F. A final section deals with the locomotives, railcars and train sets exhibited in the transport section of the Brussels Exhibition.

Wikel- und Reibungsuntersuchungen an Wellen und anderen umlaufenden Maschinenteilen. VDI-Forschungsheft 463, (1957). By FRANZ WIENEKE. Düsseldorf: VDI-Verlag G.m.b.H., Bongard Strasse 3, Düsseldorf, German Federal Republic. Price DM.15.—(VDI members, DM.13.50; subscribers DM.13.50 and DM.12.15, respectively).

IN a detailed research report, the author describes his investigations into the problems presented by the winding-on of materials on rotating shafts. These phenomena are more often than not undesirable or even dangerous, e.g. in the case of stalks getting wrapped round the shafts of agricultural machinery, or an operator's hair or clothing catching in a machine. A study of the factors involved is therefore highly interesting, not only from the theoretical point of view but even more so from the viewpoint of the designer. Dr. Wieneke deals with both these aspects of the subject, which can be subdivided into several main categories according to whether the effect is governed by dry or fluid friction or both, and whether roughness of the shaft or windage is responsible for the pick-up. The tendency of various materials to wind on under these circumstances is a function of certain physical properties such as stiffness, density, and the coefficient of friction which in turn depend on the physical state such as the degree of dryness. Although winding-on cannot in principle be prevented, any tendency for its occurrence can be minimised by various design measures.

Principes des Calculatrices Numériques Automatiques. By P. NASLIN. Dunod Editeur, 92, rue Bonaparte, Paris (6e). Price F.980.

THE aim of this book is to present the theory and design of automatic digital calculators in a readable form for technical students. The text is divided into two main parts, dealing, respectively, with logical design and with engineering construction. After a brief prologue, the reader is introduced to the binary scale and conversion between decimal and binary notations. These mathematical preliminaries are followed by an examination of the logical arrangements by which addition and subtraction can be effected. Accounts of storage, the control units, coding and programming lead to a discussion of multiplication and division and of round-off, and the first part of the book ends with a very brief mention of sub-routines and of input-output.

In the second part of the volume, a preliminary reference to gating elements and information transmission leads to a discussion of the diode and triode circuits for those purposes. The descriptions are clear but it is a pity that the author does not give some indication of valve types and component values as a practical guide to the student. There are sections on delay lines, magnetic cores, cathode-ray tubes, ferro-electric and magnetic drum storage—all well described but without practical detail. A description is given of some transistor circuits in which the similarity of this element to the electromagnetic relay is well brought out by the diagrams. Finally, there is a brief sketch of computing elements for use in the decimal scale, a note on cyclic codes, some observations on maintenance, and a section on symbolic logic.

The book can be thoroughly recommended to any reader familiar with the French language. It is clearly written and remarkably inexpensive.

Motion and Time Study. Fourth edition. By RALPH M. BARNES. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 74s.

THIS new edition enlarges and brings up to date a book that has always been one of the soundest on this subject. The title continues to indicate Professor Barnes's emphasis on the necessity of applying motion before time study, but from his first chapter he points out that these studies and the training of workers are inter-related, and "no one of them can be omitted entirely without seriously impairing the value of the study."

Many new practical examples illustrating the techniques and their uses have been added from industry, commerce and farming, and these not only show the scope of work study, but remedy what has been previously one of the main weaknesses of the book. Laboratory examples are still used to explain some of the techniques but these are now in a minority. The techniques are on the whole explained well and clearly, and a description of the use of chronocyclegraphs is now included, although the two illustrated examples are of cyclegraphs. Unfortunately, even now not enough attention is given to the study of the path of movement. Although its importance is implicit in much of what Professor Barnes writes it could be more forcefully brought to the notice of the reader. For instance, the omission of that simple, but useful technique for studying and explaining this aspect, the string diagram, is regrettable. A small section on memomotion study has been added, but the mention is even briefer, and does not do justice to its usefulness as an extension of film techniques. On the other hand, Professor Barnes's chapters on the "Principles of Motion Economy" still remain basic reading, and have been further improved by the inclusion of new examples and diagrams.

The time study chapters, too, have been amplified, and the most useful additions are probably the brief descriptions of some different systems of rating and a section on the auditing of methods and time standards. Two examples of this auditing are given to show possible systems ensuring the continuance of correct wage rates. He also emphasises the necessity of careful auditing and maintenance of wage incentive plans. A chapter on mechanical and electronic aids for time study has been added, suggesting that quicker calculation and greater accuracy will be possible in the future, but more interesting to most people now will be the chapters on predetermined motion-time systems. These give details of the three best known: work factor, methods-time-measurement and basic motion times, as well as Professor Barnes's own, which has been described more fully in previous editions. He includes a warning against untrained people trying to use these systems, but some practitioners may feel that it is not strong enough.

The chapter on work sampling is another very useful addition, and, although it is brief, it gives a comprehensive survey of the technique. It is largely statistical, but it gives all the necessary basic data. Professor Barnes does not attempt to give practical examples as in his book devoted solely to this subject, but he does discuss its use and the procedure for making a study.

Generally speaking, the book is as well produced and illustrated as previous editions. It covers the subject thoroughly and is very readable. All in all, this book is an essential one for those engaged on work study—and perhaps even more for those who are not.

Books Received

Design of Machines. By R. T. Hinkle. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 42s.

Biochemical Engineering. By R. Steel. Heywood and Co., Ltd., Ingersoll House, Kingsway, London, W.C.2. Price 50s.

High Voltage Circuit Breakers. By Vladislav Zajic. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 25s.

Trouble Free Hydraulics. By Ian McNeil. Thames and Hudson, Ltd., 30, Bloomsbury Street, London, W.C.1. Price 18s.

Technologie et Calcul Pratique des Systemes Asservis. By M. Naslin. Dunod, 92, rue Bonaparte, Paris, 6e. Price Fr.3,600

Dynamic Programming. By R. Bellman, Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 42s.

Off-Peak Electric Space Heating. By Leslie Shepherd. John D. Troup, Ltd., 90, High Holborn, London, W.C.1. Price 6s.

Metal Industry Handbook and Directory, 1958. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 15s.

Vibration and Impact. By R. Burton. Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A. Price 68s.

Japan's Economic Recovery. By G. C. Allen. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 25s.

New Ways of Building. 3rd Edition. Edited by Eric De Mare. Architectural Press, 9–13, Queen Anne's Gate, London, S.W.1. Price 45s.

Fluid-Dynamic Drag. By Dr. S. F. Hoerner. S. F. Hoerner, 148, Busteed Drive, Midland Park, New Jersey, U.S.A. Price 14.50 dollars.

The Practical Engineer. 56th Edition. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 12s. 6d.

Construction of Graphs and Charts. By A. S. Hall. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 25s.

Distribution of Deformation. Third English Edition. By C. V. Kloucek. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 50s.

The Machine Tool Trades Association (Handbook). The Machine Tool Trades Association, Brettenham House, Lancaster Place, London, W.C.2. Free of charge.

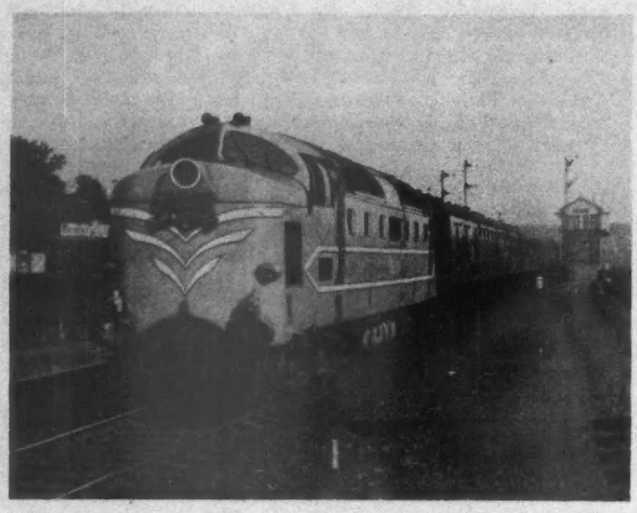
Practical Engineering Metrology. By K. W. B. Sharp. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 30s.

Engineering Economics: Book I, Elements of Industrial Organization. Sixth edition. By T. H. Burnham and G. O. Hoskins. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 21s.

Performance and Efficiency Tests on the 3300 h.p. "Deltic" Locomotive

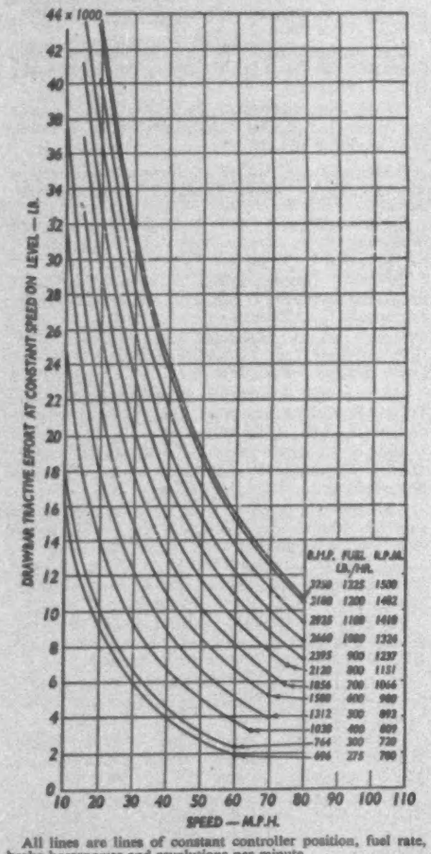
By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E., M.I.Loco.E.

Apart from its position as the most powerful locomotive at present running on British Railways, the English Electric "Deltic" has created unusual interest from its extremely high power/weight ratio. In this article the author comments upon a series of tests carried out with the mobile test plant of the former L.M.S.R., and with a trailing load of 642 tons over the Settle and Carlisle line.



AT the outset, comparison may be made of the basic power characteristics of this locomotive alongside other non-steam machines at present operating on British Railways and for which test data has been made public. A discussion of the test results from the "Deltic" may then be seen in clearer perspective. The other locomotives are :

(*a*) Brown-Boveri Gas Turbine No. 18000.
(*b*) Southern Region 1750 h.p. Diesel-electric Nos. 10201–2.
(*c*) Southern Region 2000 h.p. Diesel-electric No. 10203.



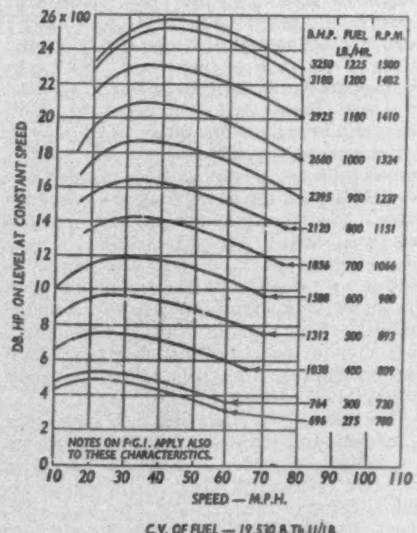
All lines are lines of constant controller position, fuel rate, brake horsepower and revolutions per minute.
Top line : maximum engine revolutions per minute and power.
Bottom line : maximum power at minimum engine revolutions per minute.
Lower power available at minimum revolutions per minute by reducing generator excitation.
Brake horsepower and fuel rate are inclusive of all auxiliaries except coach heating.

Fig. 1—Drawbar tractive effort characteristics—two engines

The last-named two locomotives are now attached to the London Midland Region.

Locomotive No.	Nominal h.p.	Maximum d.h.p. at 70 m.p.h.	Maximum d.p. at 70 m.p.h., tons	Total weight, tons	Pull : weight ratio
18000	2500	1300	2·9	119·2	0·0245
10201–2	1750	950	2·23	135·0	0·0165
10203	2000	1200	3·0	132·8	0·0226
"Deltic"	3300	2400	5·8	106	0·055

On this basis of comparison the "Deltic" yields a drawbar pull per ton of locomotive weight roughly double that of any existing internal combustion main line locomotive at present running in this country. Before coming to the actual results it will be recalled that the "Deltic" was designed and built by the English Electric Company in 1955, utilising the new light-weight design of diesel engine developed by D. Napier and Son, originally for marine purposes. By agreement with the English Electric Company, the locomotive was put into service on the London Midland Region for an extended trial period. The high power output of the locomotive made it impossible to examine its performance completely during ordinary service trials. The heaviest and fastest express passenger trains scheduled to-day do not call for an output of power extending to anything near the maximum capabilities of the "Deltic," any more than they do in the case of the largest and most powerful steam locomotives operating to-day. Thus, in addition to trials on service trains, a series of special runs was arranged over that favourite trial ground for competing locomotives, the Settle and Carlisle line.



C.V. OF FUEL — 19,530 B.Th.U/LB.

Fig. 2—Drawbar horsepower characteristics—two engines

Programme of Tests

Use of the mobile test plant was made in order to check the manufacturer's theoretic performance characteristics, and the test programme was arranged to cover the outputs obtainable with two engines, and one engine separately. Although in normal service the locomotive is designed to employ both power units together, changeover switches are provided so that either power unit can drive all six traction motors. Thus, any tractive effort obtainable with two engines can be obtained also with one engine, but at reduced speed. The range of power output with two engines was investigated by conducting tests at eight different settings of the controller, corresponding to the following nominal engine speeds : 700, 800, 900, 1050, 1200, 1300, 1400 and 1500 r.p.m. The first of these conditions was chosen to give the tractive power available at the idling speed. The maximum speed of 1500 r.p.m. corresponds to the maximum power of the engines. So far as practicable, each of these conditions was maintained for the whole of a particular test run. The first fifteen to twenty minutes of each run were devoted to warming up under conditions approaching those of the test. The engine revolutions per minute were then set to the required value, using the driver's controller, and the actuator air pressure was noted, as a means of accurately maintaining and reproducing the engine revolutions per minute. At fixed controller setting, engine revolutions per minute, fuel consumption and brake horsepower remain virtually constant, and all test measurements were made under these conditions. During each test, the mobile test units were employed to control the road speed in increments of 5 m.p.h. The normal duration of any of these constant speed steps was five to ten minutes, according to circumstances. Continuous records of speed, drawbar tractive effort and horsepower, and so on, together with fuel consumption in 1/5 gallon increments were made in the dynamometer car throughout

each test. In addition, the following electrical and diesel engine data were recorded.

Main traction circuit current No. 1.—Main generator voltage No. 2.—Main generator voltage No. 1.—Auxiliary generator current No. 2.—Auxiliary generator current	By continuous oscillograph recording
Nos. 1 and 2.—Auxiliary generator voltages	By logged readings
Fuel temperatures (both engines) Engine-room ambient temperature Fuel rack setting in degrees (No. 1 engine) Fuel rack setting in degrees (No. 2 engine)	By logged readings
Engine r.p.m. (No. 1 engine) Engine r.p.m. (No. 2 engine)	By continuous electrical recording (1 impulse per revolution)

All records were synchronised by six-second time traces, originating from the recording table of the dynamometer car. These readings were all required to provide the data for establishment of the performance characteristics of the locomotive. In addition, detailed logs of engine exhaust, cooling water and lubricating oil temperatures were maintained to ensure satisfactory engine performance. Similar procedure was adopted for the tests with one engine employed, i.e. 800, 900, 1200 and 1500 r.p.m.

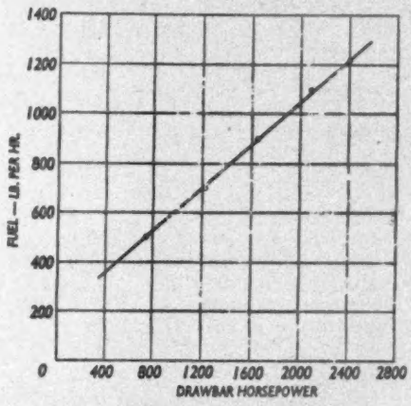


Fig. 3—Fuel per drawbar horsepower-hour—"Deltic," at 70 m.p.h.

Test Results

From the numerous graphs in the bulletin, depicting all facets of the performance of the locomotive, some have been chosen, for inclusion in this article, which indicate the kind of work that may be expected from the locomotive in ordinary railway service. First of all there is the diagram of drawbar tractive effort with two engines, Fig. 1. At maximum revolutions per minute, with a constant brake horsepower of 3250 from the motors, the locomotive provides a drawbar pull of 5·8 tons at 70 m.p.h. on level track. The entire weight of the locomotive, 106 tons, is available for adhesion, indeed on a special test a maximum drawbar tractive effort of 20·2 tons was sustained for two minutes without slipping, this representing a ratio of drawbar pull to adhesion weight of 19 per cent. The limit in this case was not adhesion, but the setting of the overload relays, which are set to limit the traction current to a maximum of 2700A.

From the drawbar tractive effort characteristic curves there follow the curves of drawbar horsepower, Fig. 2. One of the most interesting features of the performance of the locomotive to be deduced from these graphs is the rate of rise of the fuel rate, in relation to increase of drawbar horsepower. Two additional graphs, not in the bulletin, have been prepared to show how widely this characteristic differs from the corresponding one of a steam locomotive. Fig. 3 relates the drawbar horsepower of the "Deltic" at 70 m.p.h. to the fuel rate, while Fig. 4 shows the corresponding graph for a class "8" express passenger steam locomotive of the 4-6-0 type.

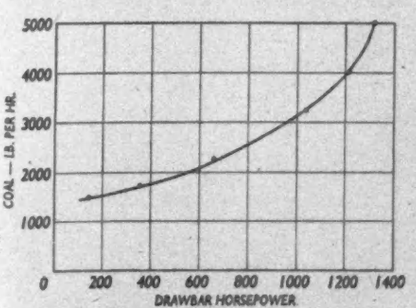


Fig. 4—Coal per drawbar horsepower-hour—"King" class 4-6-0 at 70 m.p.h.

Comparison of the curves shows clearly how difficult and arduous it is to extract the utmost from a steam locomotive when maximum power output is approached, and why it is desirable to plan train schedules to make no more than a moderate demand, particularly if locomotives are hand fired.

Fuel Consumption

One of the most marked features of some other forms of non-steam locomotive previously tested and operated in this country has been their comparative inefficiency at all except maximum output. The "Deltic" shows a notable constancy in basic fuel consumption. Fig. 5 illustrates the family of graphs of fuel per drawbar horsepower-hour, with two engines, and at 70 m.p.h. it will be seen that between 1000 and 2400 d.h.p. the difference in fuel per drawbar horsepower is no more than that between 0·51 lb and 0·61 lb per hour. The "Deltic" thus operates at near maximum efficiency over a wide range of power output. Maximum efficiency occurs at a speed of about 40 m.p.h., when at full revolutions per minute the drawbar horsepower is highest in relation to the output at the engine shaft. The diagram in Fig. 6 shows the various losses, and their varying values in relation to speed. The value of locomotive resistance was determined from results of a number of coasting tests at controlled speeds between 10 m.p.h. and 80 m.p.h. The long stretches of steeply falling gradient on the Settle and Carlisle line are particularly suitable for this kind of examination.

Performance and Traction Efficiency

The interpretation of test results in terms of the haulage of passenger and freight trains of different loads and different running is one of the most interesting features of the bulletins issued by the British Transport Commission, and Fig. 8, taken from among many included in the bulletin, shows what can be expected from the "Deltic" in the haulage of a train of 500 tons weight of passenger stock. From this diagram the following table has been prepared:

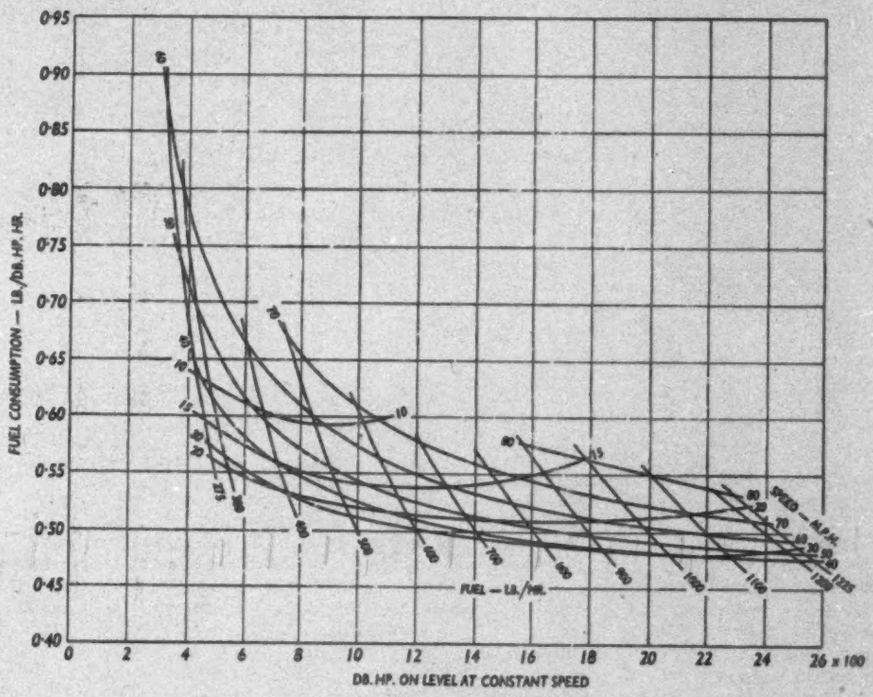


Fig. 5—Fuel per drawbar horsepower-hour—two engines

500-Ton Passenger Train

Gradient	Fuel, lb per hour	Sustained speed, m.p.h.	Available tractive, d.t.e., lb
Level	900	80	7,400
1 in 300	900	63	9,600
	1,100	71	10,500
	1,225	76	11,000
1 in 200	900	55	11,000
	1,100	64	11,700
	1,225	69	12,300
1 in 100	900	39	15,700
	1,100	47	16,300
	1,225	51	16,700

The locomotive was not tested at speeds over 80 m.p.h., but the designed maximum is 105 m.p.h.

The announcement by the British Transport Commission that twenty-two "Deltic" locomotives are to be built for service on the East Coast Route naturally invites comparison with the famous steam "Pacific" engines of Sir Nigel Gresley's design that are at present at work on this route. The performance of the "Deltic" on a fuel consumption of 900 lb per hour corresponds roughly with

the optimum one could expect from the streamlined "A4" class, with, for example, a speed of 80 m.p.h. on the level with a trailing load of 500 tons. The drawbar horsepower is approximately 1550, and the relative fuel consumptions are :

Haulage of 500 Tons : 80 M.P.H. on Level

Locomotive	Diesel-electric "Deltic"	Steam, 4–6–2 "A4"
Type of fuel	Fuel oil	Coal : Grade 1A hard
Calorific value of fuel, B.Th.U. lb	19,530	14,000
Pound per d.h.p.-hour	0·58	2·2
Pound per hour	900	3,400

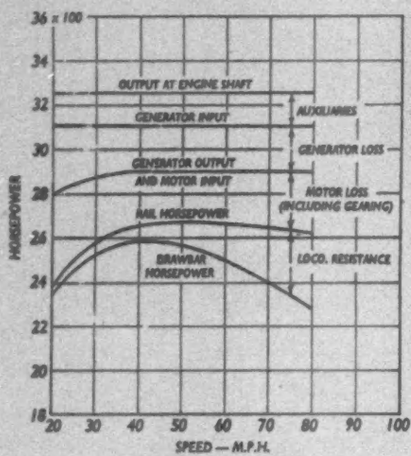
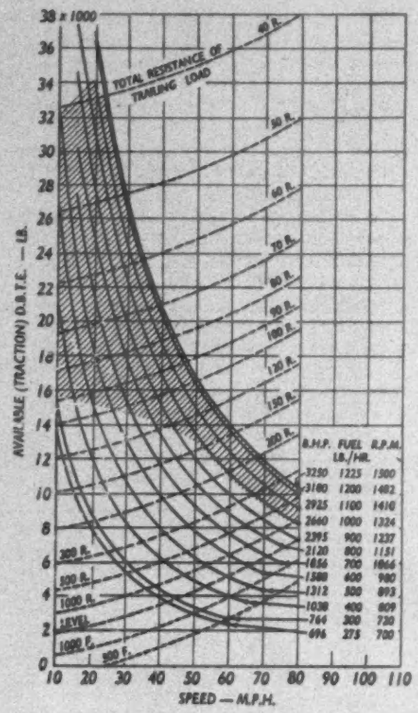


Fig. 6—Power distribution at 1500 r.p.m.—two engines

While it could not be expected that any but the most expert and enthusiastic of steam locomotive crews would be able to sustain such a performance as the above for any length of time the "Deltic" has a considerable margin in reserve, as is shown in the table on page 61. No physical work, but a mere adjustment of the controls is enough to increase speed from 55 m.p.h. to 69 m.p.h. while climbing a 1 in 200 gradient.

Road Test with 642-ton Trailing Load

The basic performance data obtained in tests with the mobile test plant is of great



The hatched band covers all rates of working for which fuel per available drawbar horsepower-hour is within 2 per cent of the minimum at each speed.
Legend to Fig. 1 is also applicable to this diagram.

Fig. 8—Performance and traction efficiency—two engines, 500 tons passenger train

interest and importance, as indicating the theoretical and actual capabilities of the locomotive ; but to railway operating men no doubt the most convincing demonstration lay in the haulage of a trailing load of 642 tons between Skipton and Carlisle at start-to-stop average speeds of 54 m.p.h. to 58 m.p.h. On one of the fastest and hardest steam locomotive runs ever recorded over this route, one of Sir William Stanier's "Jubilee" class of three-cylinder 4–6–0s made times closely similar to those of the "Deltic," as between Carlisle and Aisgill summit, but with a load of no more than 305 tons. The steam locomotive and its tender weighed 133 tons in working order, so that the advance in power-weight ratio as represented by the "Deltic" locomotive is very marked, namely :

Locomotive	Ex-L.M.S. "Jubilee"	"Deltic"
Weight in working order, tons	133	106
Load hauled, tons	305	642
Ratio, train to engine weight ...	2·3	6·05

Performance data obtained with the "Deltic" during the Skipton–Carlisle trials were as follows :—

Results of Tests with 642 Tons Train Load

	Carlisle-Skipton	Skipton-Carlisle
Load and number of vehicles, tons tare	642 (20)	642 (20)
Distance :		
Actual, miles	82·9	82·9
Under power, miles ...	57·9	47·9
Ton miles (tare weight of trailing load)	53,222	53,222
Time :		
Actual running, minutes ...	91	86
Actual, under power, minutes	64	50
Actual, drifting and braking, minutes	27	36
Average speed :		
On running time, m.p.h. ...	54·6	57·9
Under power, m.p.h.	54·3	57·5
Work done : actual d.h.p. hours	2,075	1,452
Average actual d.h.p.	1,943	1,743
Average actual d.t.e., tons ...	5·99	5·08
Oil :		
Gross calorific value, B.Th.U. per pound	19,560	19,560
Total used, pounds	1,183	876
Used under power, pounds...	1,118	799
Average rate under power, pounds per hour	1,048	939
Used while drifting and braking, pounds	65	77
Average rate while drifting and braking, pounds per hour	144·3	128·2
Pound per available d.h.p.-hour on total fuel used	0·571	0·602
Pound per available d.h.p.-hour under power	0·539	0·549
Pound per mile on total fuel used	14·29	10·58
Pound per mile under power	19·30	16·68
Pound per ton-mile on total fuel used	0·0222	0·0164
Energy transmitted to trailing load x 100/energy in total fuel	22·8	21·6
Energy transmitted to trailing load x 100/energy in fuel used under power (traction efficiency)	24·2	23·7

The diagram, Fig. 7, gives a graphic summary of the running on a southbound journey as between Durran Hill Junction (Carlisle) and Aisgill summit. From the speed curve it will be seen that the train passed the latter point at 50 m.p.h., at an altitude of 1151ft

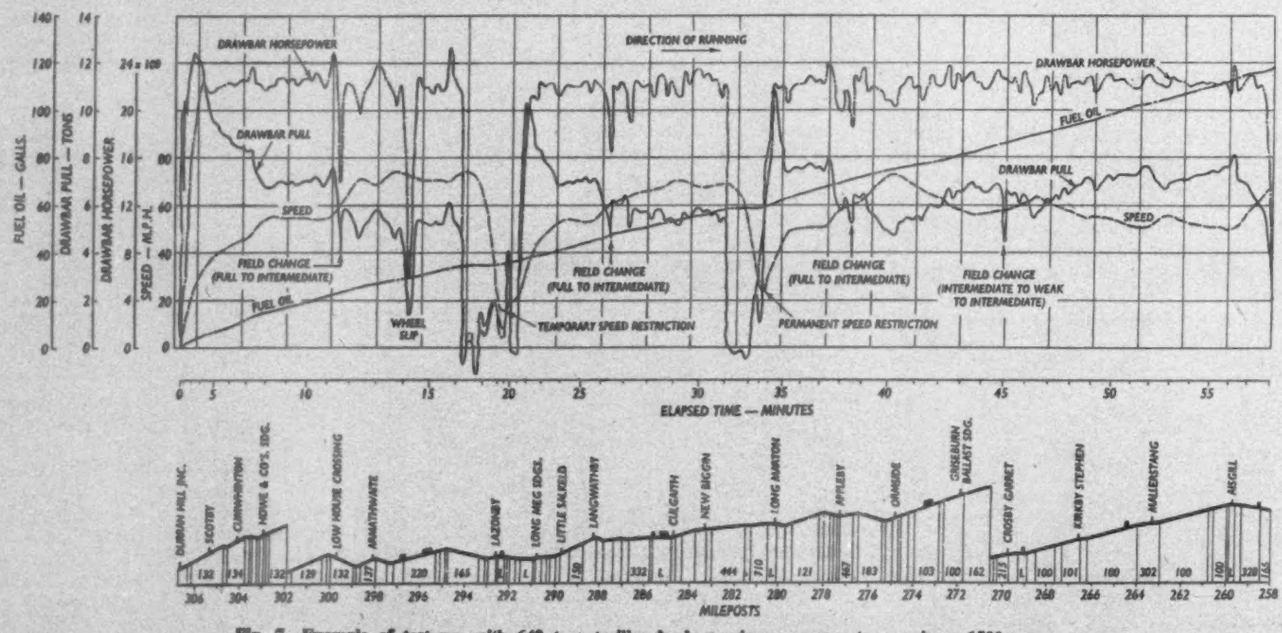


Fig. 7—Example of test run with 642 tons trailing load, maximum power—two engines—1500 r.p.m.

above ordnance datum, reached in 48 miles from the start at Carlisle.

Conclusions

From the various graphs extracted from the British Transport Commission's bulletin and reproduced in this article it is evident that the " Deltic " is a machine of exceptional competence, and performance of the locomotives of the same type now on order for the East Coast route will be keenly anticipated. It is reported that the engines are smooth-running and free from vibration, requiring very little maintenance work during the tests. They did prove somewhat noisy when running at idling speed, and this proved objectionable when standing in stations. The locomotives as a whole proved remarkably trouble-free, a total mileage of approximately 5000 being covered during the course of the tests, without any mechanical or electrical defect of any significance. On one occasion, a run had to be completed with two traction motors out of circuit, but this was due to a deliberate overload, imposed during wheel slip tests, which caused one of the motors to flash over.

Power for a Sugar Refinery

WHEN the steam and power plant at the Westburn Sugar Refineries in Greenock was examined in 1952–53 it was found to be inadequate, and the provision of a new power station was entrusted to Powell Duffryn Technical Services, Ltd. It was decided to run the station in parallel with the national grid. The site selected was a natural embankment sloping down from the firm's railway sidings. There was extensive excavation, and a reinforced retaining wall was built from basement level to the top of the embankment. This covers the length of the power and boiler-houses, and goes further to allow clear access to the ashpit and to provide space for a fourth boiler. A reinforced concrete raft was considered adequate as foundation for the boiler stanchions and the self-supporting steel chimneys. The floors of the turbine and boiler-houses are at the same level : they are made of reinforced concrete supported on steelwork. The turbo-alternator foundations are carried down from the level of the turbine room to safe bearing ground : they are of heavy-framed reinforced concrete. The building has a steel frame and the walls are of 9in brick up to 3ft above firing floor level. Above this there is insulated panelling of aluminium alloy, also used for the roof decking. We give below some of the leading features of the station :

(i) Three coal-fired two-drum water-tube boilers with integral superheaters and economisers Maximum continuous rate 40,000 lb per hour at 275 lb per square inch and 650 deg. Fah. working conditions.

(ii) Two back-pressure impulse turbo-alternators putting out 750kW at 0·75 power factor when supplied with steam at 250 lb per square inch and 625 deg. Fah. and a back pressure of 15 lb per square inch at 350 deg. Fah. Governed on speed and/or back pressure.

(iii) Main switchboard comprises a 14-panel, 415V, 35MVA air circuit-breaker board with alternator control gear incorporated. Feeds taken directly to the refinery, and also through a 600kW rectifier to supply equipment at 240V d.c. (Consideration was given to the possibility of generating at 3·3kV instead of 415V, but it was decided that the economy of the latter made it preferable.) Surplus energy (averaging 600kW) is exported to the S.S.E.B. through a 750kVA transformer.

(iv) Main transformer connecting to 11kV grid rated at 750kVA. Twelve-phase glass-bulb rectifier rated at 600kW.

(v) Desuperheater in turbine exhaust to provide process steam at maxima of 15 lb per square inch and 260 deg. Fah.

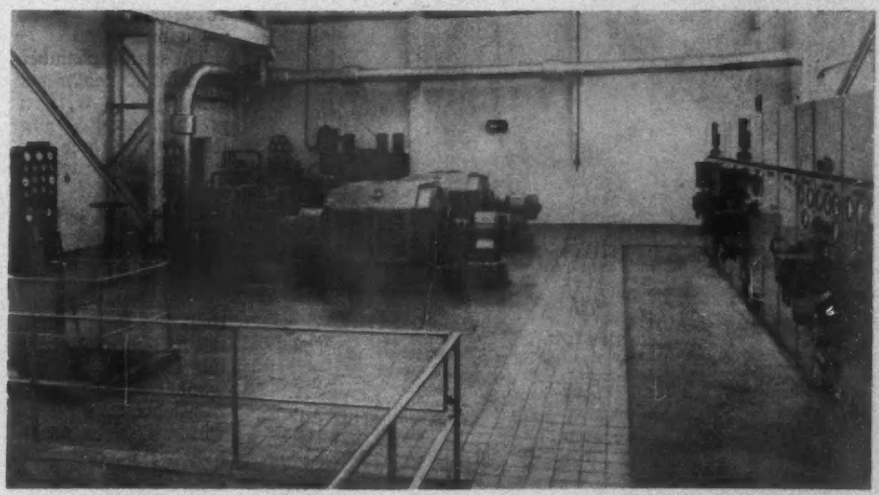
(vi) Pressure reducing and desuperheating sets to bring boiler stop valve conditions to (*a*) 15 lb per square inch, 260 deg. Fah., 28,000 lb per hour in case of complete failure of turbine plant ; (*b*) 165 lb per square inch, 385 deg. Fah., 4000 lb per hour to supply process steam to sugar granulators.

(vii) Existing Ruths steam accumulator is in parallel with old boilers. Reducing valve between new boiler and accumulator brings pressure down to 160 lb per square inch. Superheated steam is fed at about 18,500 lb per hour to accumulator, now connected in series to act as storage desuperheater. Discharge to process is at 16,000 lb per hour average, 60,000 lb per hour maximum, at 30 lb per square inch pressure.

(viii) Sixty-five-ton coal reception pit at rail siding level, and ash pit at basement level, both of concrete. A telfer moves coal from the reception pit to the boiler bunkers, and ash from the pit to trucks.

We understand from Messrs. Powell Duffryn that among the leading contractors were the following :—Boilers, travelling grate stokers, auxiliaries, &c., Babcock and Wilcox, Ltd.; turbo-alternators, W. H. Allen, Sons and Co., Ltd.; main switchboard and 415V air break, switch and fuse gear, The British Thomson-Houston Company, Ltd.; motor starter boards, &c., for boilers and power plant, The Belmos Company, Ltd.; transformer and rectifier, The Hackbridge and Hewittic Electrical Company, Ltd.; six panel d.c. distribution board, Bertram Thomas, Ltd.; desuperheaters, James Gordon and Co., Ltd.; accumulator system, Ruths Accumulators (Cochran), Ltd., Clayton-Chambers, Ltd.; main boiler-house pipework, Babcock and Wilcox, Ltd.; turbine-house pipework, Stewarts and Lloyds, Ltd.; auxiliary pipework in refinery, turbine-house and boiler, Clayton-Chambers, Ltd.; main cables supplied by Johnson and Phillips, Ltd., and installed by Osborne and Hunter, Ltd.; lighting, Watson-Norie, Ltd.; ash and coal handling plant, Robert Dempster and Sons, Ltd. The architects were Messrs. Young and Purves and the main civil engineering contract was with Whatlings, Ltd.

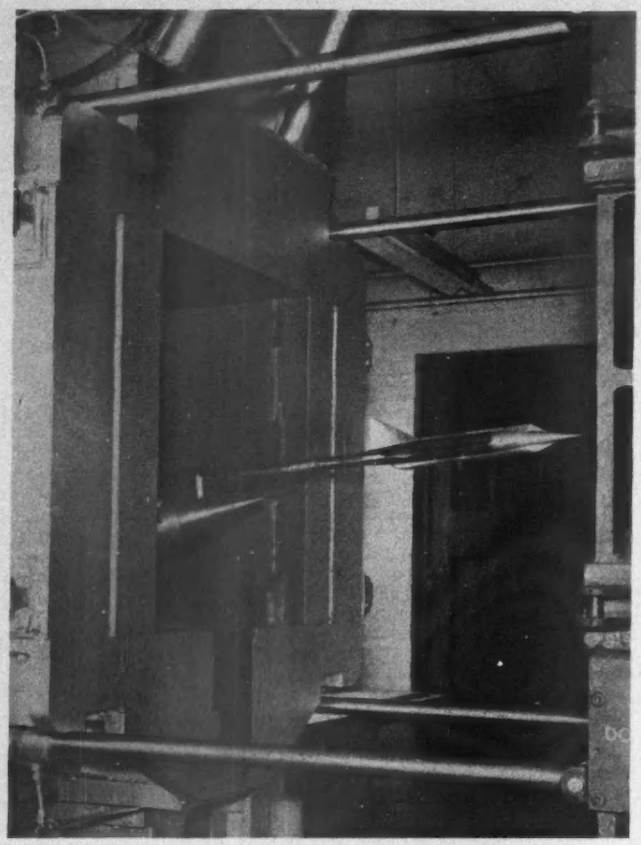
A view of the new power station erected at the Westburn Sugar Refineries, Greenock, Renfrewshire



Turbine room of power station for Westburn Sugar Refineries, illustrating the main auxiliary a.c. switchgear and the 275 lb per square inch steam main. The latter goes to an accumulator in the refinery buildings

Blow-Down Tunnel

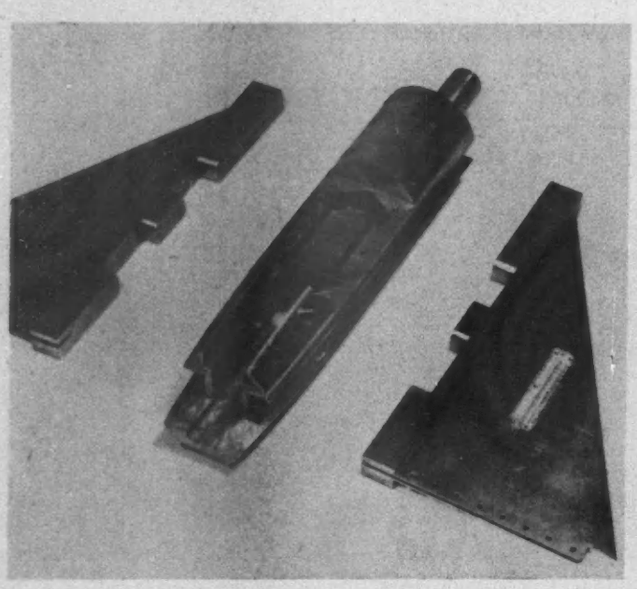
What is believed to be the largest example in Europe of a Mach 3·5 wind tunnel is now in operation at the Woodford aerodrome of A. V. Roe and Co., Ltd. In this picture the diffusers have been moved back from the 30in by 27in working section to expose a model of the Avro "720" experimental mixed-power-plant delta which, it can be seen, would have closely resembled a "Mirage."



A SUPERSONIC tunnel working between Mach numbers 1·6 and 3·5 has been built by A. V. Roe and Co., Ltd., at their Woodford aerodrome. Originally intended to support the supersonic bomber programme, the facility was built as an intermittent blow-down tunnel because of the great reduction in cost, so that it can carry out flutter tests on flexible models and boost separation tests on model missiles which would be repugnant where the air was passing to a compressor. It has been given a working section of 30in by 27in, identical with that of the tunnel now being completed by the Aircraft Research Association for continuous operation at similar Mach numbers; models will be interchangeable between the tunnels, with the proviso that those built for the Bedford tunnel may not be strong enough for a tunnel running always at total pressures well above atmospheric. In this context it is interesting to note that this tunnel, when run at low Mach numbers near to its maximum pressure of six atmospheres, can achieve higher Reynolds numbers than the 8ft by 8ft tunnel at R.A.E., Bedford (described in our issue of July 5, 1957, page 21).

The air storage vessel is a sphere 40ft in diameter, containing 100 tons of scrap steel sheet as a heat reservoir to minimise temperature changes during a run; runs last up to 40 seconds and can take place at intervals of about 70 minutes. It is charged to 100 lb per square inch by a pair of conventional compressors with 210 h.p. electric motors, six-sevenths of the atmospheric moisture being removed in the subsequent cooling and the remainder by activated alumina driers which give a dew-point of −60 deg. Cent. The air charge weighs 7¼ tons, but the water used for a test to 220 lb per square inch *in situ* weighed 1500 tons and this was the design case for the 40ft concrete piles supporting the sphere, which was fabricated by Whessoe of 1¼in plate.

The sphere delivers to a 36in diameter Harland "Rotovalve," driven through a rack and pinion by a hydraulic ram which allows it to cover its full travel in 2 seconds. The method of operation is for the valve to open at full speed to a position calculated to give the desired running pressure with a charged reservoir, and for the further movement to respond hyperbolically to changes in reservoir pressure; this gives a stagnation pressure constant within ±1 lb per square inch at 60 lb per square inch, and the closed-loop trimming servo sensing pressure in the settling chamber is not in use. The valve is the one fixed point in the run of the tunnel, and its pedestal was strain gauged to confirm that the horizontal forces existing during acceleration were negligible.



The model "720" before assembly: notice that a strain-gauge drag balance has been formed from the solid metal to accept the sting

The settling chamber contains a perforated steel plate with a pressure drop of 30*g* followed by three fine mesh screens each of 2*g* drop. The contraction, with a ratio of 17 : 1, goes from circular to rectangular, and so pressure loads are taken by a surrounding shell. Since the pressure of air in the intervening space would not follow rapid transients, oil is placed within it. The nozzle may be likened to a simplified version of that in the R.A.E. tunnel aforementioned; the ordinates for 190 Mach numbers, differing by 0·01, between 1·0 and 3·5 are stored on punched tape and fed directly to solenoids driving screwjacks in increments of 0·002in. Unlike the big tunnel, displacement monitors and a second set of tape readers are not needed; running being intermittent, it is possible for the staff to check the nozzle setting between runs by reference to odometers on the jacks. As a safeguard against straining the 0·45in flexible plates, however, the whole system shuts down if a difference of 0·020in arises between adjacent jacks. The nozzle is fixed to the working section, eliminating joints which might disturb the flow, and there are 22in diameter schlieren windows each side of the model.

The performance of the diffuser is of some importance, since any pressure recovery obtained lowers the minimum reservoir pressure needed to sustain flow: the difference between the pressures needed to establish and maintain a given Mach number becomes significant beyond M. 2·5, and at M. 3·5 these pressures are respectively six and four times atmospheric. The supersonic diffuser consists of two hinged plates which are set before the run; the hinge at the leading edge can be seen in our heading illustration. The subsonic diffuser is circular in section and delivers the air vertically upwards both for safety reasons and to avoid end thrusts on the tunnel.

The diffusers can be moved downstream to give access to the model. The incidence gear is mounted on the supersonic diffuser, and consists essentially of a parallelogram linkage within a streamlined division in the centre of the diffuser. The top link is extended upstream to the same length as the sting; thus by moving the end of this link in unison with the parallelogram, the sting and model can be lowered into a recess in the floor of the tunnel when starting and stopping, to avoid the extreme loads imposed on the model by the unsteady flow. Retraction is only necessary above M. 2·5, at which

speed the shock from the leading edge of the recess passes well clear of the model ; at lower Mach numbers the recess is covered over. As the incidence is changed the model remains at the same height, except for a small error caused by the swinging ram carrying the extended end of the top link being of less than infinite length ; our heading picture shows a cranked sting which allows the model to be mounted yawed. The incidence programme is preselected and initiated by sensing settling chamber pressure ; when the model is raised the incidence may change, progressively or with pauses, at up to 15 degrees per second.

Instrumentation is also largely automatic. Moments and forces on the model are obtained from strain gauges feeding chart recorders with self-balancing potentiometers sensitive to 0·25mV ; the balancers also drive commutator-type digitisers which reduce the quantities to reflected binary code, in which it is displayed by a neon store with space for ten numbers of ten digits. This store is frozen and recorded on punched tape at pre-set intervals, the tape being compatible with the Avro computer, a Ferranti Mk. I. Pressures are taken through small-bore piping to a " Scannivalve " which connects up to forty-eight tappings in rotation to a strain-gauge transducer ; the volume and response time of the latter are so small that a sampling interval of ¼ second is used. The control device allows only the first of so many of the forty-eight to be monitored before returning to number 1 ; the output is recorded as a continuous pen trace on a high-speed Honeywell recorder, the readings appearing as short dwells in the trace.

High-Speed Metal Removal

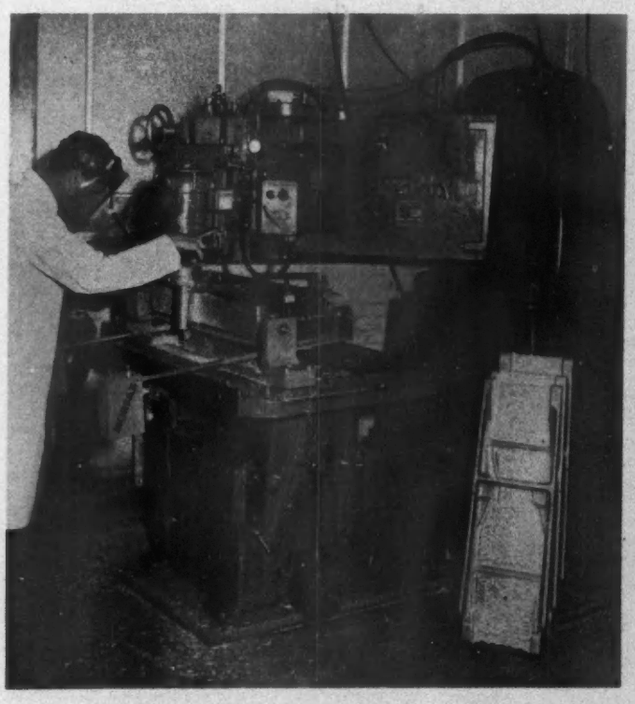
As the name indicates, Routing, Ltd., offers a specialised machining service. We describe here some of the devices and processes used in the generation of three-dimensional components.

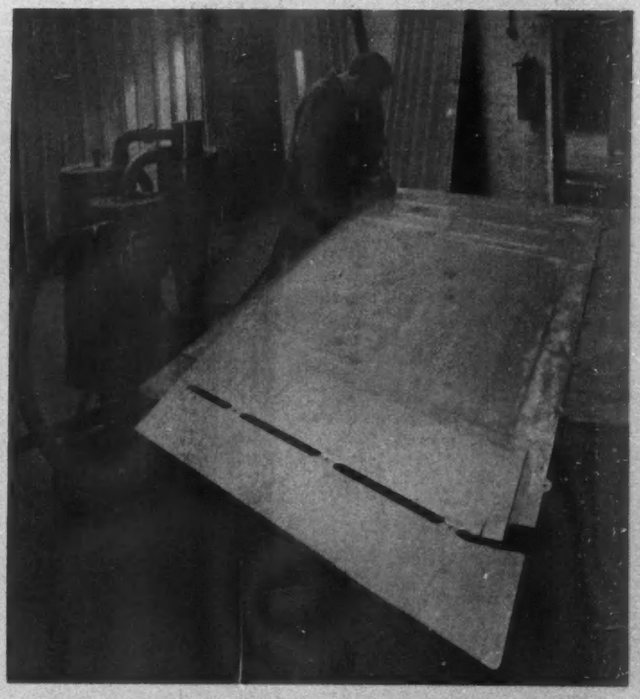
WE recently visited the new premises at Faggs Road, Feltham, Middlesex, of Routing, Ltd., an associate of Morfax, Ltd., which will perform the work previously done in the production routing department of the parent firm. The firm specialises in the application of routing, not to the cutting of blanks from sheet, but to the preparation of three-dimensional shapes in light alloy or steel. (The parent firm, which does the experimental work, holds a Ministry of Supply contract to investigate the routing of titanium.) The shapes required are found to be orthogonal in concept, with large surfaces plane, or defined by straight-line generators, and hence classical routing machines and two-dimensional templates are the tools used. Cutters are fitted with carbide tips, secured by copper welding, and the limiting cutting speed is usually dictated by the danger of tips leaving the tool. The workheads are invariably driven by hand without power assistance : this allows the operator to use his judgment to limit local heating of the workpiece, while it is found that for the small quantities usually ordered, times to set up and inspect are so much larger than the machining time that increased metal removal rates are hardly necessary. Cutters are cooled by soluble oil mist when working light alloy and carbon dioxide for high tensile steel, with the effect that machines and shop are unusually clean.

We illustrate some of the fixtures and processes in use. The illustration overleaf shows a vacuum chuck ; in order to allow flat workpieces of any size to be held, the surface of the chuck is incised with ¼in grooves 0·23in deep, and an area smaller than the face of the job is isolated with ¼in rubber piping. The chuck is shown prepared for the largest acceptable workpiece ; the ends of the rubber pipe are, it can be seen, led off at the top right-hand corner of the face. A more usual form of vacuum chuck is a horizontal table facing the cutter head, in which case the chuck is faced by its own machine so that, whether it is perfectly plane or not, workpieces which comply with it will be free from variations in depth.

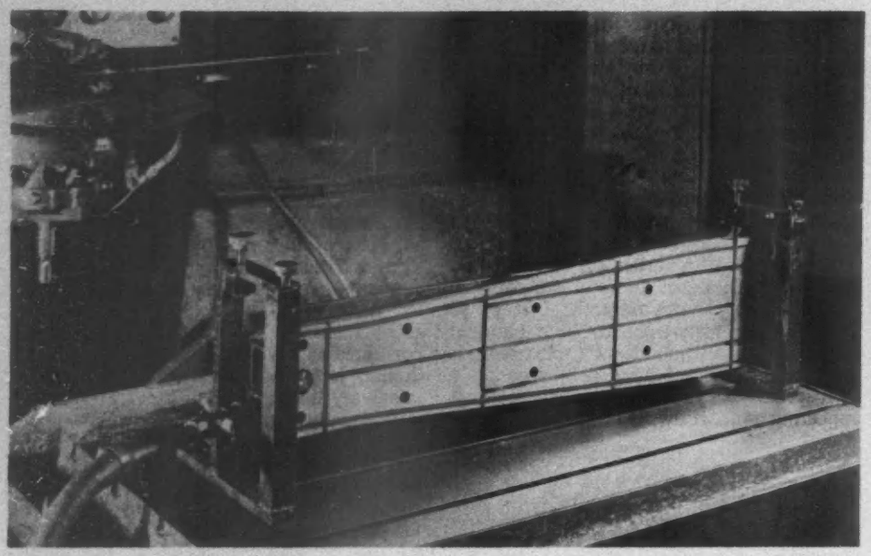
Below, left, is shown a process applicable to the evolution of a wide range of solids bounded by straight line generators contained within parallel planes. The surface desired is projected on to two planes by imaginary lines at right angles to some axis, conveniently within the plane of the workpiece. The two resulting figures are then cut out as templates and secured to the workpiece in such attitudes that they define the required surface. The assembly of job and templates is offered up to a routing machine so that it may rotate about the above-mentioned axis, and that axis is at right angles to the cutter spindle. Then, with collars mounted on the cutter head opposite both templates, the cutter is fed into the job; the template-workpiece assembly will rotate until both templates are in contact with the follower collars, and hence complex shapes may be obtained. To minimise the contact forces on the templates, the swinging fixture is counterbalanced.

Large routing machines with the weight of the cutting head supported on tracks, eliminating the varying yield of an articulated arm, are used for milling large slabs to form aircraft skins. Form cutters are used, since the section of an integral stiffener is far from arbitrary. An example of a component skin milled in this manner is seen below, right, with the freshly cut face being vacuum blasted with coarse alumina to improve its fatigue properties. While such a shape may appear to be one which could more cheaply be formed by chemical milling, that process had, we are advised, proved unsatisfactory.





(Left) Workpiece located between two templates to allow generation of an inclined edge. (Right) Vacuum blast treating a milled skin panel of light alloy



A vacuum chuck in position on a router. Notice the mist lubricant spray pipe. The lever on the handle-bar controls a pneumatic brake upon articulation of the arm

Subsequent attachments to this component are by " Redux " bonding, and the two end sections, separated from the main panel by slots, are used to provide sample bonds for destructive testing.

A large part of the work involved is, of course, devoted to the preparation of templates. It is found that the design of the finished product has usually been prepared by full-scale lofting, and therefore it is considered that the information needed to guide the machine may more easily, as well as more cheaply, be stored on a template rather than as instructions to a computer. The accuracy attainable, limited by concentricity of cutters and collars and by flexibility of the machines, is usually about 0·003in, and hence the templates are required to lie within rather wider limits than tools generally ; they are prepared by hand marking out, band-sawing, and hand dressing. Location holes are placed, not with a jig borer, but a " Bokö " boring machine which, having been found capable of reproducing work within 0·005in, has been fitted with Hilger Watts optical setting.

Seventy-five Years in Telecommunications

AN exhibition was held in London last week to mark the seventy-fifth anniversary of the company which is now known as Standard Telephones and Cables, Ltd. This firm originated with a staff of three in an office in Moorgate where, in 1883, an agency was set up for importing the telephone—then in its infancy. Now the company is a large manufacturing organisation with a wide range of interests, employing 25,000 men and women at eight major factories in the United Kingdom. Its products cover the whole field of telecommunications and extend beyond it to include power cables, static rectifiers and capacitors for power factor correction.

Ninety-nine exhibits were on show last week, giving an outline of the history of the company, through its products, and illustrating the scope of its activities to-day. In the space at our disposal we cannot, unfortunately, refer to more than a few of the many exhibits that we saw at the Press preview. An appropriate starting point for a tour of this exhibition was the display of historic valves, ranging from an original specimen of the Fleming diode (1904), to its modern derivatives, such as the " Brimar " RA/DX2B, a very-high-voltage miniature rectifier for use in television receivers ; many triodes, including a 1907 Audion, and a 1915 W.E.C.O. " Peanut," one of the early miniature valves ; and a Standard 4036A " Microray " tube (1931–35) which was used in the first public demonstration of microwave links in 1931. To bring the story up to date, there were a travelling-wave amplifier (CV2188) as used in the Manchester-Kirk o'Shotts microwave link (and designed to operate in the 4000 Mc/s band) and a special-purpose tetrode (CV427) which is designed for pulse outputs, with a peak anode rating of 15A.

Telecommunications, direction finding and radar are among the applications for these modern valves. Several examples were exhibited : for instance, the Commutated Antenna Direction Finder (C.A.D.F.), a new system which is applicable to the h.f., v.h.f. and u.h.f. frequency bands and is claimed to be the most notable advance in direction-finding since the introduction of the Adcock aerial in 1916. Another navigational aid, the " Starn 21," is an airborne version of the company's " TACAN " navigational system. It is a 126-channel equipment capable of giving bearing and slant-line distance to a number of aircraft, relatively to a fixed ground station at ranges up to 200 nautical miles.

Yet another airborne equipment is the radio teleprinter which provides a new means of communicating with the pilot of an aircraft in flight, as was demonstrated successfully for the first time on March 6, 1956, when a B.O.A.C. " Stratocruiser " on a scheduled flight from London to New York recorded automatically, on an airborne teleprinter, meteorological and navigational reports transmitted from radio stations in Britain and Newfoundland.

For use on airfields, the " SLA3 " Precision-Approach Radar has been designed to give accurate information on the position, in elevation, azimuth and range, of an approaching aircraft in relation to the touch-down point on the runway. A mobile version of this radar is already in operational use at the Royal Aircraft Establishment, Bedford, and is in production for the R.A.F. The static version is in operation at Bromma Airport, Stockholm.

The " STRAD " system of telegraphic retransmission, which was the subject of a group of exhibits, has been developed to provide increased " cross-office " handling speeds in telegraph relay centres and to simplify handling of the multiple-route message and cope with increasing volumes of traffic. Transistor circuitry is used throughout and the equipment can be operated either automatically or, if required, semi-automatically, by push-button control. Storage and memory functions can be performed on magnetic drums or on ferrite matrices. " STRAD " equipment was installed recently at Gatwick Airport, as described in our issue of June 27, 1958, page 981.

There were a number of exhibits illustrating some stages in the progress of telephony, from a replica of Graham Bell's telephone (1876) to a model of a modern rocking-armature telephone receiver. This receiver has a bi-polar form of symmetrical magnetic system. The incoming signal energises the coils, causing the armature to " rock," whereupon the minute movement is passed to the coned diaphragm by a short connecting rod. The diaphragm converts the vibrations into sound. Compared with present receivers, there is marked improvement in " loudness " and fidelity of speech reproduction. This type of receiver has been adopted by the G.P.O. for use in all new telephone sets.

Communication of a more specialised form is provided by systems such as the " Standard " Simple Supervisory System, which comprises a small simplified self-contained system of remote control and indication equipment. It uses a coded signalling technique and operates over two or four pilot wires, or equivalent voice frequency telegraph or radio channels. Up to fifteen control functions can be initiated from the control panel (as shown at the exhibition), which will also display a maximum of fifteen indications from the remote outstation. Two-way telephony is included without prejudice to the operation of the signalling system. In addition to constant pilot-line proving, safeguards are included which prevent mal-operation of the remote equipment. Owing to its flexibility, the system has many possible applications, such as water-pumping stations, small unattended electrical distribution stations and hydraulic works.

Another means of communicating information was exemplified by a train describer system. Such systems usually have the description displayed above the control panel by means of lamps and stencils. A new development is an electronic character generator for the display of train descriptions by means of cathode-ray tubes, the information being selected from a master generator and switched to the required display positions. Thus, it is possible to select and display any combination of twenty-six letters and ten numbers in the one aperture of any number of cathode-ray tubes. Because of the small size, the display can be mounted in the control panel, adjacent to the track section to which it refers.

Outside the orbit of telecommunications, one of the interesting exhibits was a " SenTerCet " 2·6MW silicon rectifier power plant. The cubicle shown was one of twelve similar equipments forming part of a 20,000A, 130V, d.c. power plant to be used in South Africa for the electrochemical extraction of manganese and uranium. Each cubicle houses four hollow busbar assemblies mounted vertically side by side. On the front face of each bar are clamped twelve silicon diodes. Thus, there are forty-eight diodes per cubicle and 576 for the full 20,000A output. Cooling oil enters at the foot of each hollow bar and leaves at the top through connections on the rear faces of each bar and forms, with an oil-to-water heat exchanger, a closed forced-oil system.

THE ROLLS-ROYCE " DART " R.DA.10 TURBO-PROP has successfully completed a twenty-five-hour flight approval test at a military rating which provides 3200 s.h.p. for take-off boosted with water methanol, with a normal rating of 2650 s.h.p. The condition of the engine on strip was, we are informed, excellent. The test, which was officially observed by the Air Registration Board, was run at more stringent conditions than required by the regulations : for example, 56·6 per cent of the test was run at maximum continuous power as compared with 30 per cent required in a normal type test.

SHORTER REPORTS

Anglo-American Agreement on Atomic Energy

A WHITE PAPER (Cmnd. 470, price 6d.) has been presented to Parliament detailing the agreement reached between the governments of the U.K. and the U.S.A. on co-operation in the military use of atomic energy. Generally, the agreement provides (but not unreservedly) for exchanges of information, materials and equipment. With regard to information, the terms cover the planning of defence, training, evaluation of the abilities of potential enemies, development of "delivery systems compatible with the atomic weapons they carry," research on military reactors, and matters of weapon design and "fabrication." The government of the U.S.A. also undertakes to sell "one complete submarine nuclear propulsion plant with such spare parts therefor as may be agreed." Reactor cores or fuel elements for replacements will be supplied for ten years from the coming into force of the agreement, as will also quantities of uranium enriched in U^{235}. However, atomic weapons (not the transporting or propulsive means) are specifically excluded.

The terms of the agreement include a proviso that nothing in it shall be interpreted as a bar or restriction on consultation or co-operation in defence by either party with other nations or international organisations. But secret information is, of course, not to be passed on to any third party, and policies on secrecy classification are to be agreed. Patent and royalty rights are also set out in the White Paper. The agreement will come into force when each government has received from the other written notice that it has complied with all that is statutorily and constitutionally required. Termination is to be by mutual consent, or by a specified form of notice on either side.

Air Registration Board

THE report of the Air Registration Board for the year ended March 31, 1958, marks the end of twenty-one years' activity by that body. The report observes that the "fail safe" design, as compared to the "safe life" concept, eases the problem presented to the airworthiness authorities by the wide scatter of component lives under fatigue. The attitude of the Board to the certification of erstwhile military aircraft, which has given rise to much criticism, is deemed flexible, there being no rules for determining individual cases.

The Board, with assistance from the Society of British Automobile Constructors, undertook a line-by-line comparison of British and United States airworthiness requirements; the majority of the differences were found to be so minor that each country would accept the other's equivalent, but the remainder gave rise to special requirements. Many of the U.S. requirements were subsequently embodied in those of the A.R.B., thus reducing the C.A.A. list of special requirements, which, in the case of the Bristol "Britannia," numbered about 150. For performance requirements the differences were greatly reduced by the formulation and revision of the separate U.S. regulations for turbine-engined aircraft.

As a result of experience with the "Britannia" 100 aircraft, which experienced difficulty in icing conditions about which almost nothing was known, the Board now requires all new turbine transports to be test flown in natural dry ice conditions.

For aircrew licensing examinations the objective form of question and answer paper was adopted, with satisfactory results, although more time is, of course, required for the preparation of the papers.

Parking Experiments

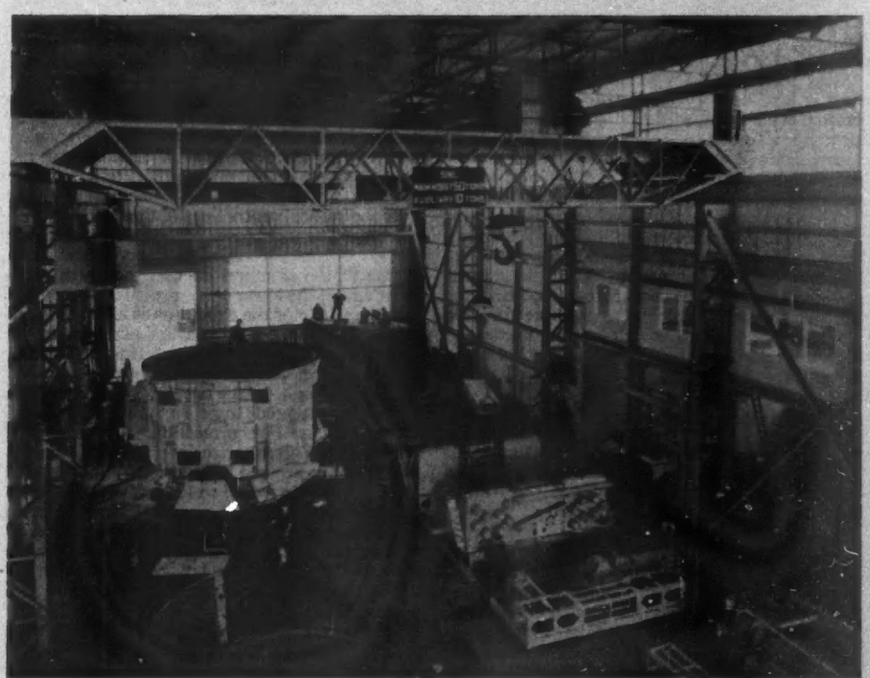
THE British Road Federation issued this week a report on the problem of parking vehicles in urban areas, prepared on its behalf by Mr. C. P. Andrew, M.Sc. (Eng.), A.M.I.C.E. The Federation realises that the function of vehicles is such that they must be brought to rest in city centres for longer or shorter periods, and that if that is not possible in any city, then rateable values will decline correspondingly. It is realised that experiments with parking meters are imminent, but these waste the space available by dividing it into blocks of a fixed size and, by involving the vehicle operator in expense, may discourage him from patronising institutions that depend on his custom. The Federation therefore submit that further experiments are necessary with, for instance, the "Paris disc" system, where a vehicle is left with the estimated time of departure displayed, and with meters demanding only a nominal levy of, say, ½d. The detailed proposals are developed for the case of Kingston-upon-Thames, Surrey, and it is recommended that this town, which with factories, offices and shops distributed round through-routes presents many problems, should be regarded as an experimental parking town. Three schemes are recommended for trial: in all of them part of the street parking space is allocated to commercial vehicles exclusively, and the amount of off-street parking space is increased. In general, the Federation believes that businesses involving the parking of cars, such as retail stores, should be encouraged to provide parking facilities, but it emphasises that off-street parking is a facility that may be expected from local government authorities even as are washhouses and libraries.

Works Reconstruction Scheme

THE first stage of a comprehensive reconstruction and modernisation scheme at the works of Sheppard and Sons, Ltd., Bridgend, Glamorgan, was completed recently when a large new fabrication and erection shop was inaugurated. Under this scheme, which is to be carried out in five stages, the older buildings are to be progressively demolished and replaced by modern structures. The firm was established nearly a hundred years ago for the manufacture of cleaning and treatment plant for coal and other minerals. The steadily increasing scope of the firm and the restrictions imposed by the size and lay-out of most of the existing shops when building the larger types of special equipment it was called upon to supply, led to the decision to embark upon the plan of works modernisation and extensions, now in hand.

The new shop, one end of which can be seen in the accompanying illustration, is some 170ft long by 70ft wide and there is a clearance of 30ft from the hook of a 50-ton capacity overhead travelling crane which serves the full length of the building. It is a steel frame structure with double-clad asbestos sheet walls, and is well glazed to provide effective natural lighting over the whole working area. The far end wall of the shop in the illustration is of light temporary construction, as under the next stage of the reconstruction scheme the building will be extended from that end and the wall removed. Two typical examples of the larger classes of plant construction and heavy welded steel plate work which the firm is carrying out can be seen on the floor of the shop. The large electric smelting furnace being assembled on the left-hand side of the shop is one of two similar 40-ton capacity units being built to the order of G.W.B. Furnaces, Ltd. for a Canadian order. Each complete furnace installation will weigh some 236 tons. In the right-hand far corner of the shop there is being welded a precision heavy plate assembly weighing about 32 tons, which will be used as a flame deflector at the Spadeadam Rocket Research Establishment.

The plate work and machined parts for the heavy fabrications and other equipment assembled in the new shop are prepared and machined in the older adjoining shops of the works. With the introduction of the extended facilities for large assembly work additional production space has been made available in the other fabricating and assembly shops for the wide variety of structural, plate and sheet work undertaken.



New erection shop which forms the first stage in the reconstruction of the works of Sheppard and Sons, Ltd.

Dumper fitted with Meiller placer

The central span of the Samawa bridge is 245ft

Placer-Dumpers

We are informed that the "Meiller Placer-Dumper" system, consisting of a hydraulic lifting and placing jib for vehicle skip bodies has now been adapted for use on Muir-Hill dumpers, made by E. Boydell and Co., Ltd., Manchester, 16. With this equipment the dumper skip may either be tipped *in situ* or swung right out and placed on the ground, as can be seen in the accompanying illustration. As the skips are readily interchangeable, several bodies may be utilised and wasteful standing time by the dumper and driver avoided.

Hydraulic jacks provided at the rear end of the vehicle relieve the rear suspension of all strain when jacking up and lowering the skip. These jacks are pivot mounted and they are lowered into position from the cab as required. All controls are grouped on a panel to give ease of operation, and the main hydraulic rams are throttle controlled, allowing for high-speed working when lifting an empty skip.

The skip tipping action is effected by a retractable hook which is operated by a single-acting, spring-return hydraulic ram, and a simple means of preventing accidental tipping is provided by the interconnection of this ram with the rear support jacks. Skips may be tipped to 120 deg. and are available in various forms and in two capacities for payloads of 5 tons and 3 tons 13 cwt.

The Muir-Hill "2WL" loader made by the firm is also now available with a new type of bucket, which can be tipped either to the front or to one side of the machine. This bucket, with a capacity of 1 cubic yard, can be used for lorry loading, hopper filling, and similar jobs, where angles of approach are necessarily restricted.

The new bucket is fully interchangeable with the standard buckets in the existing range and requires the addition of a separate control valve, and a three-bank selector in place of the normal two-bank unit. The bucket can be used for normal front end tipping as well as for side tipping; for forward use a pin catch is engaged and the removal of the pin permits the bucket to be used for side tipping.

Structural Engineers' Conference

The Institution of Structural Engineers has announced details of a conference to be held in London next October, to celebrate the Institution's fiftieth anniversary. Technical sessions will take place on the mornings of October 8, 9 and 10, and there will be visits to places of engineering interest, together with a variety of social functions and entertainments.

The papers to be presented number about forty, covering materials, design techniques and classes of structures. The technical sessions are grouped with two sessions in progress simultaneously. Each session has a general reporter. The sessions cover: structures for electrical power; bridges; flat slabs, skin structures and composite construction; researches applied to various structural problems; structural analysis; construction in steel; precast concrete; foundations; and two more general sessions. Delegates will be attending from many countries.

Suspension Bridge at Samawa, Iraq

The first modern suspension bridge in Iraq was opened by that country's Minister of Communications and Works recently, at Samawa, a township on the banks of the Euphrates about halfway between Baghdad and Basrah. The bridge carries the highway on the western route between the capital and the port and provides an important link in the new trunk road programme of the Iraq Development Board. Messrs. Posford, Pavry and Partners were the Iraq Development Board's consulting engineers for the bridge, and the main contractor was Sir William Arrol and Co., Ltd.

The new suspension bridge is a self-anchoring structure. It has a length between abutment bearings of about 527ft, the supporting towers being positioned at the quarter points to give a clear navigational opening of about 245ft. The headroom under the bridge at maximum recorded flood level is 16½ft. The carriageway is 26ft wide, and two footways, each 6ft wide, are cantilevered out from the main girders.

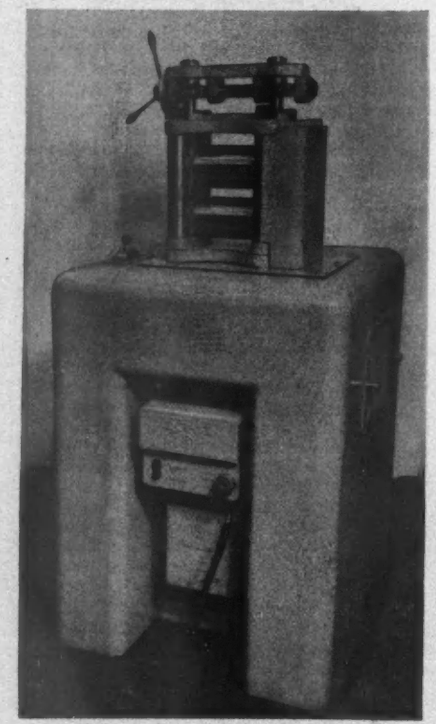
These main girders are box-shaped, 85in deep by 29in wide with ½in thick web and flange plates connected to 8in by 6in by ¾in corner angles. The towers are also of box section and are splayed to enable the main girders to pass inside the legs while carrying the cables immediately over the vertical centre lines of the girders; they are hinged at their bases. The main girders are carried on fixed trunnion bearings at the south abutment, on trunnion links at the north abutment and at the lower cross girders of the towers, and the whole of the expansion is allowed for at the north abutment with a flat plate expansion joint. All the steelwork is high tensile steel.

The suspension cables each contain 270 galvanised high tensile steel wires of 0·276in diameter, gathered together into a hexagonal cross-section. For protection, the completed cables were given a sealing coat of barium chromate paste and then tightly bound with 10 gauge soft iron wire, which was painted simultaneously with the remainder of the structure. From the last hanger the wires splay out to their anchorages and this portion was given protection by pouring hot bitumen around it to encase it completely. The cable hangers are formed from 1¼in diameter steel bars fixed to the girders by trunnions. Services are carried under the footways and access manholes are built into the pavement but the lighting cables for the sodium lighting on the bridge are carried in the handrails.

Small Power Rolling Mill

The prototype of a small power mill developed by Syd Abrams, Ltd., Waterloo Road, Manchester, 8, illustrated below, is intended for use in the light sheet metal trades, and for precious metals, lead strip, &c. It has 4in diameter, 6in wide rolls, the spacing of which can be adjusted by raising or lowering the upper roll through its bearing housings. These housings slide on the main columns and are moved by lead screws interconnected through worm gearing on a cross shaft turned by a capstan handle.

The rolls are driven by a motor enclosed within the cabinet base through reduction gearing and a worm shaft, giving a rolling speed of 6·5ft per minute. The length of worm on the upper part of the shaft is sufficient to cover the range of top roll adjustment, which, in the case of the prototype machine, is ¾in. It is pointed out by the maker that the range of roll adjustment and rolling speed can be arranged in accordance with particular users' requirements.



Small power-driven mill with 6in wide rolls for precious metals, lead strip, &c.

Training for "Hollerith" Equipment

IT is essential for the effective application of "Hollerith" automatic calculating and computing machines, that there should be full appreciation of their potential uses and that operators should be well trained. For this reason an important part of the organisation of the British Tabulating Machine Company, Ltd., is the provision of training facilities for those concerned with the installation, programming, operation and maintenance of the firm's machines. This section of the firm is also primarily concerned with the training of new members for its own demonstration and installation staff, and with keeping its representatives up to date with machines of new design and developments made in applications.

For this work of training the firm has five main centres, two of which we recently visited—"Moor Hall," Cookham, Berks, and Bradenham Manor, Bradenham.

The Moor Hall establishment has training facilities and residential accommodation for about 150 students, and of the 2000 people trained here each year, some 75 per cent are for the staff of customers and the remainder are "Hollerith" staff. Most of those trained are to be machine operators or supervisors of an installation. There has, however, for some years been a growing tendency for the managers and executives—those ultimately responsible for an installation—to attend the centre for what are termed "appreciation courses." At this centre there was also set up some time ago a regular series of executive courses to help management to keep abreast of the latest developments in machines and equipment, and in their applications. Twenty or more such courses are held every year, and, by 1957, they had become so popular that a second country house in Cookham—"The Grange"—was opened as a residential centre where accommodation is provided for twenty executives.

Bradenham Manor is organised as a residential computer training centre for some sixty trainees. The courses held at this centre include "appreciation" and "refresher" courses, and electronic computer programming courses, and they vary in duration from four-day refresher courses to eight-week programming courses. At both of the centres there has been installed a comprehensive selection of the kinds of machines in general use, as well as examples of the latest designs, to ensure that every trainee gets the fullest possible benefit from the course undertaken.

Further training facilities are provided at the Hollerith computer centre at 36, Hertford Street, London, W.1, where one-day and four-day computer "appreciation" courses are regularly held for directors and top management personnel. The centre is equipped with a modern film and lecture theatre, conference rooms and a demonstration "Hec" computer. It is the focal point for study groups and specialist teams where a free interchange of knowledge and experience in planning for computer employment and actual usage is promoted between those who have similar types of problems and are able to discuss possible solutions in a common language. One such group, for example, is composed of local government officers whose authorities have installed or are in the preliminary stages of introducing "Hec" general purpose electronic computers.

On the actual manufacturing side of the firm's activities, comprehensive training facilities for engineering craft computer technicians and student apprentices are provided in the works schools at Letchworth and Castlereagh.

Boiler Scaffolding

WE are informed that specially designed scaffolding constructed from "Self-Lock" frames supplied and erected by the Mills Scaffold Company, Ltd., Trussley Works, Hammersmith Grove, London, W.6, are being used for access to the interior of the water-tube boilers at Marchwood generating station, near Southampton. The frames, measuring 5ft by 2ft, have to be passed one at a time into the boiler through a manhole measuring 2ft by 1ft 3in. It is stated that tests six months ago showed that thirteen men can erect or dismantle a complete scaffold in thirteen hours, compared with the three days required when using standard 2in diameter scaffold tube and fittings, so that the cost of the scaffold frames is absorbed by the saving from reduced shutdown.

The system was first employed in a John Thompson water-tube boiler putting out 550,000 lb per hour. Designed for coal firing, it had been modified for oil burning. The modifications included closure of the ashpit by a false floor of fire bricks carried on a framework of T-section girders. The scaffolding consisted of nine towers joined together by ties. The three central towers were 70ft high and were carried on the false floor of the ashpit. The two trios of towers on either side were supported on cantilevers at the base of the central frame, and rose to a height of 56ft and 60ft respectively, the difference being due to the sloping roof of the boiler. The clearance between the inside face of the boiler and the scaffolding was found to be approximately 6in, and lengths of 2in diameter scaffolding tube ("ledgers") were attached to the towers, the ends of the tubing butting against the boiler walls and supporting the scaffolding on all four sides.

The base of the boiler, showing the scaffolding supported by cantilevers from the central towers

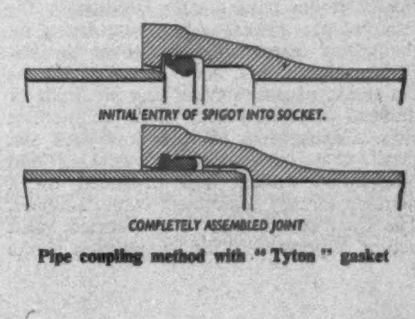
Joint for Cast Iron Pipes

A LICENCE has been acquired by the Stanton Ironworks Company, Ltd., near Nottingham, for the supply of the "Tyton" flexible pipe joint developed by the United States Pipe and Foundry Company. This joint for water, sewage, or industrial pipe mains, is at present available from Stanton for 3in, 4in and 6in diameter spun iron pipes to B.S. 1211.

As can be seen in the accompanying diagram, the joint between the spigot end of one pipe and the socket end of the adjoining pipe has a rubber gasket of special shape and construction. This gasket is initially retained by a groove round its outer circumference, which registers over a retaining bead in the socket. As the spigot pipe is slid into the socket the bulbous rear part of the gasket is deformed and compressed between the two pipes to form an effective annular seal. The leading edge of the spigot is chamfered to facilitate the initial passage through the gasket and any tendency to tear the gasket from the hold of the circumferential groove on the retaining bead is avoided by the previous application of a special lubricant to the inner sealing surface of the ring.

When pipes are being coupled together using this form of joint no special tools are required, the spigot pipe being simply levered in using crowbars at its outer end. If required, a form of fork tool can be supplied to facilitate the coupling operation.

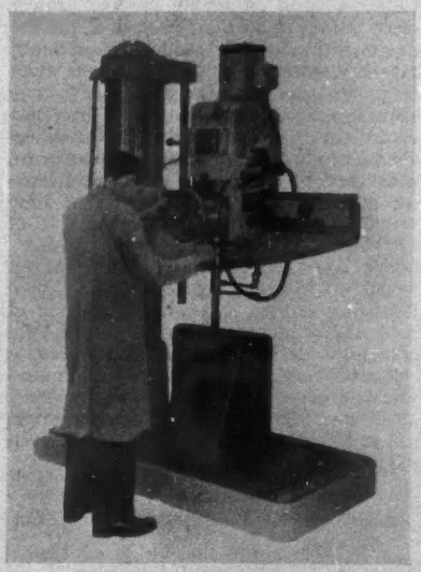
We are informed by the makers that in tests on this type of joint the internal hydrostatic pressure was raised progressively to 3500 lb per square inch with a joint deflected to 5 deg. In a further test with the joint in line, an internal pressure of 5000 lb was applied. In each of these tests, it is stated, there was no leakage at the joint.



Pipe coupling method with "Tyton" gasket

Radial Drilling Machine

WE illustrate below a 1½in capacity radial drilling machine, which is now being made in two models of 37in and 49in radius by Qualters and Smith Brothers, Ltd., of Barnsley, one of the Kerry group of companies. The inner column member of the machine carries the outer sleeve on roller bearings, and the sleeve is locked in the required position by a quick-action clamp designed to eliminate risk of deflection. A 1½ h.p. elevating motor driving through a worm wheel and nut on a stationary screw raises and lowers the arm, and when the directional control lever is released the arm is automatically locked.



1½in capacity radial drilling machine, with nine spindle speeds and three feed rates

The drill head moves freely along the arm on needle roller bearings and is fitted with a 3 h.p. reversing motor, which drives through the gearbox. Nine rates of spindle speed are available in three alternative ranges of 60 to 750 r.p.m., 90 to 1120 r.p.m., and 120 to 1500 r.p.m., and speed selection is effected through levers on the side of the head. The three rates of power feed are 0·004in, 0·008in and 0·016in per revolution, and means of quick hand traverse and fine hand feed are provided. The spindle nose is bored No. 4 Morse taper.

Industrial and Labour Notes

Relaxation of Credit Restrictions

On Thursday of last week, in the House of Commons, the Chancellor of the Exchequer, Mr. Heathcoat Amory, made an announcement about the relaxation of credit restrictions. He prefaced his statement by saying that the Government's economic objectives were fundamental and unchanging, namely, to put the strength of sterling, the soundness of the country's position internationally and price stability first. The policies by which those objectives could be reached must be kept flexible ; in particular, it was desirable to go ahead, as fast as conditions allowed, in those activities concerned with the export trade and in industrial investment.

The Chancellor went on to say that he considered the time had come when " some limited relaxations in the control of borrowing " could safely be made. He had therefore decided that he need not ask the banks to restrict the total level of their advances to any given figure after the end of July. For the future, he hoped to dispense with official requests to restrict total advances and to retain control over bank credit by normal monetary measures reinforced by a new arrangement under which the Bank of England would restrict, if need be, the liquidity of the banking system by calling for special deposits. Then, the Chancellor continued, it had been decided to make adjustments in the scope of the capital issues control. The new provisions were : the Capital Issues Committee might take a longer view in examining proposals which came before it, so that, instead of limiting its consents to proposals which were currently urgent, it might assent to applications which anticipated future needs ; in view of the new arrangements for securing the necessary control of bank credit, the Capital Issues Committee would no longer be concerned with the appropriateness of bank finance for capital purposes ; the exemption limit would be restored from the present level of £10,000 to the former level of £50,000 ; bonus issues or capitalisation of reserves would no longer come before the Capital Issues Committee, but where the issue of redeemable securities was involved, the consent of the Treasury would be needed.

The Chancellor added that the Government was determined not to return to inflationary conditions. But, he said, it was clearly right to encourage such sound development as was judged to be within the country's capacity.

Industrial and Commercial Finance Corporation

In his chairman's statement at the recent annual meeting of the Industrial and Commercial Finance Corporation, Lord Piercy said that, like so many measures of a general kind, the incidence upon the various parts of the economy of the recent phases of credit restriction had been uneven. So far as concerned the checking of the ability to invest, it had fallen most heavily on those sectors of the economy which had no access to the new issue market, i.e. the small and medium sized companies and especially new and expanding ones. The run of applications which had come before the Corporation, Lord Piercy continued, seemed to suggest that this stringency had come at a period when there were new springs of enterprise among small concerns, and it had made more difficult the lot of quite an interesting crop of new ventures.

Lord Piercy went on to remark that the era of the credit squeeze had now lasted a considerable time if its inception could be placed at the end of 1951. The Corporation, he said, was set up to provide capital funds for concerns without easy or ready access to the capital market and particularly firms of small and medium size. It was set up with a massive background of resources, but every time the squeeze had deepened in severity, the Corporation had been straitened as regards funds. The developments of the economic situation at home and abroad in the next few months, he added, might alike enforce the desirability of reviving investment in manufacturing industry.

Coal

A statistical statement issued last week by the Ministry of Power shows that coal output in the first six months of this year amounted to 112,933,100 tons, compared with 117,829,800 tons in the corresponding period of last year. Opencast production, at 6,929,000 tons, was somewhat higher in the first half of the year, but deep-mined output was 5,000,000 tons lower than in the comparable months of last year. Between January and the end of June this year, coal imports amounted to 510,100 tons ; in the comparable period of 1957 they totalled 1,775,100 tons. Inland coal consumption over the first six months was much the same as a year earlier, but export and bunker requirements were nearly 2,000,000 tons lower. Distributed and undistributed coal stocks on June 21 totalled 27,786,000 tons.

On Monday, in the House of Commons, the Paymaster-General, Mr. Maudling, was questioned about coal production. In particular, he was asked about absenteeism, which increased to 14·22 per cent in the first half of this year (from 12·84 per cent a year earlier). In his reply, Mr. Maudling referred to the fall in the demand for coal, saying that production had been kept in reasonable balance by restrictions in recruiting and by the stoppage of Saturday working and limitation of overtime. He acknowledged that absenteeism in the coalfields continued at a high rate, and remarked that it had been " fairly constant for some months." He went on to say that he certainly did not view with equanimity this continued rate of absenteeism in the coalfields. But the fact was that a good deal of the reduction in production had been the result of deliberate policy, such as reducing recruiting and limiting overtime, which had been brought in by the National Coal Board in face of the reduced demand for coal and the very large stocks which were piling up.

In his presidential address at the annual conference of the National Union of Mineworkers, which began on Monday, Mr. Ernest Jones urged that the National Coal Board should have greater freedom in the fixing of coal prices. After commenting on the falling demand for coal over the last twelve months, Mr. Jones talked about the big stocks of coal surrounding pit heads or dumped in disused quarries or at opencast sites. Much of it, he said, was slack and small coal from opencast working and mechanised mining and depended on a market already saturated with supplies. The Coal Board, Mr. Jones asserted, must accept responsibility for the increase in the proportion of small coal and the reduction in large coal which was in great demand. The Board, he added, was not entitled to despoil the agricultural resources of Britain to produce coal, 28 out of each 100 tons of which it was unable to sell and had to stock. Because much was unsold, the Board's argument that opencast coal was so profitable was absurd. Opencast development, Mr. Jones considered, should be curtailed immediately and present opencast production cut by at least a quarter.

Steel Development

An announcement made this week by Colvilles, Ltd., says that it is intended to make a start immediately on the construction of a slabbing mill at the Ravenscraig works, Motherwell. The Ravenscraig plant was described in THE ENGINEER of August 2, 1957, in which issue there was also included some reference to the slabbing mill project. The mill, which is part of the company's second development plan, is designed to roll ingots from 10 to 40 tons and will ultimately have an annual capacity of 1,500,000 tons.

This week's announcement says that the second development plan is not to be retarded by the temporary fall in steel demand. Reference to this matter is made in the summer issue of *Colvilles Magazine*, which says " there is no avoiding the fact that over the past few months uncertainties have developed in the steel industry which were not foreseen a year ago." The recession, it is stated, is caused partly by a " de-stocking crisis " ; consumers are " living on the fat they accumulated when conditions for stock-piling were favourable." But, it is added, the long-term future for steel is secure, although, Colvilles, Ltd., says, " we do not know when it will arrive."

Colonial Development

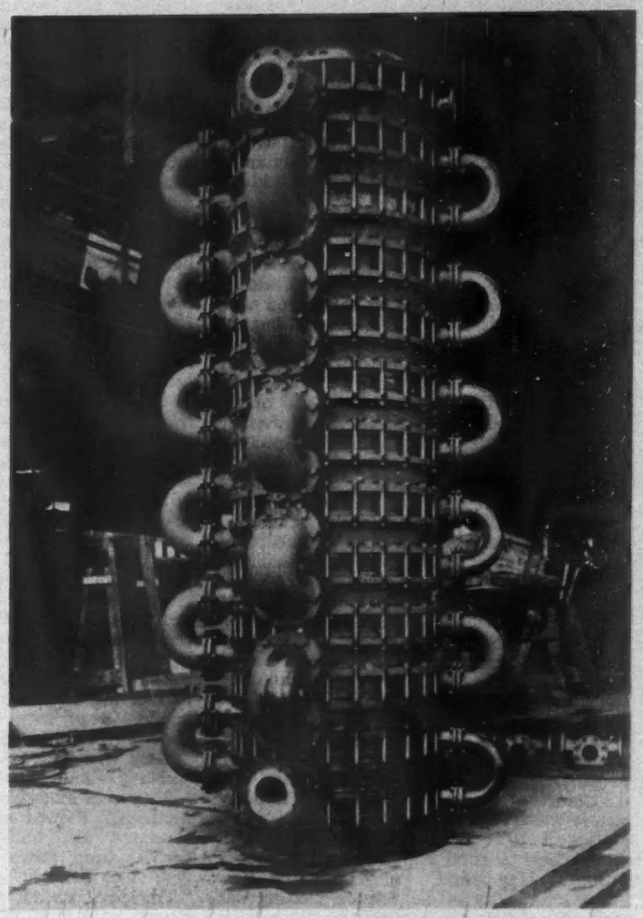
The Colonial Office has stated that grants for development projects in overseas territories, which were approved by the United Kingdom Government in the last financial year, totalled £17,380,563, with an additional £1,123,850 for research schemes. In the twelve-year period ended March 31 last, the actual issues on Colonial development and welfare votes amounted to £156,156,137, of which £13,266,291 was spent on research.

Grants approved last year included £5,331,284 for communications, of which £3,481,312 was for road development and £1,105,115 for civil aviation. Grants for education amounted to £3,989,383, and other allocations included £1,129,461 for physical planning, surveys and census, £572,660 for housing and town development, and £729,564 for water supplies and sanitation. The intensification of African agriculture accounted for £1,016,000 of the development grants approved for Kenya during the year. Grants for the development of the University College of East Africa amounted to £451,010, and the grants to Tanganyika included a total of £568,000 for road development, and to Somaliland £283,000 for the development of Berbera port. Education accounted for £1,054,855 of the development grants approved for the Federation of Nigeria. Grants to Sierra Leone included £113,629 for Fourah Bay College.

Twelfth Achema Congress and Exhibition

No. I

The twelfth Achema Congress and Exhibition of Chemical Apparatus was held in Frankfurt-on-Main from May 31 until June 8, in conjunction with this year's Congress of the European Federation of Chemical Engineering, the Second Corrosion Congress, and other important meetings. The Achema (Ausstellungstagung für Chemisches Apparatewesen: "exhibition-congress for chemical apparatus") which is now held at three-yearly intervals has established itself as perhaps the most important event of its kind in the field of chemical technology. It seeks to bring into contact, on an international basis, the makers and users of chemical equipment, by means of lectures, discussions, demonstrations, and the exhibition itself. In what follows, we first deal with the organisation of the Achema and the programme of lectures, and then proceed to describe some of the highlights of the exhibition.



DURING the period May 31 to June 8, the Twelfth Achema Chemical Engineering Congress and Exhibition took place in Frankfurt-on-Main. In conjunction with this event was held the Second Congress of the European Federation of Chemical Engineering, the first part in Brussels on May 23 and 29, and the remainder in Frankfurt from May 31 to June 8. Also held jointly with the Achema Congress was the Second Congress of the European Federation of Corrosion, the 1958 Special Meeting and lectures of the Gesellschaft Deutscher Chemiker; this year's annual meeting of the Dechema Deutsche Gesellschaft für Chemisches Apparatewesen; the first annual meeting of the Isotopen-Studien-Gesellschaft, and the special meeting of the Deutsche Gesellschaft für Arbeitsschutz, in connection with the celebration of its fiftieth anniversary.

This year's Achema, like its predecessors since the series first started in 1920, was organised by the Dechema Deutsche Gesellschaft für Chemisches Apparatewesen E.V., Frankfurt-on-Main. It is the object of the Achema Congresses to promote research and development in the field of chemical engineering and technical chemistry by arranging "individual discussions at actual exhibits" and by lectures, so as to stimulate an exchange of experience between chemists and engineers, scientists and technologists, and the manufacturers and users of plant and apparatus. The importance of the exhibition may be gauged from the fact that in 1955, when it was last held, the total value of the exhibits amounted to DM.30,000,000. This year it covered some 700,000 square feet of floor space in fourteen halls as well as 53,800 square feet of open-air space, an increase of 30 per cent over 1955. Exhibitor members of the congress were drawn from fifteen European and overseas countries, a total of some 950 firms. The growth of the Achema may be gauged from the following figures covering the last four exhibitions:

Year	1950	1952	1955	1958
Total number of exhibitors	451	563	850	1,050
Foreign exhibitors... ...	9	37	106	150
Foreign countries	9	10	12	15
Total exhibition area (square metres)	27,000	31,000	50,000	70,000
Total value of exhibits (DM.million)	6·8	12·5	25·0	50·0
Participants enrolled for total period	4,200	7,500	12,000	15,000*
Part-time participants ...	24,000	38,000	59,000	Over 80,000

* 60 per cent of the visitors came from fifty-two foreign countries. In addition, 4300 students registered for the special courses of lectures and practical work.

Exhibits were grouped according to the following technical fields: "Research and Literature," "Chemical Technology," "Nuclear Science and Technology," "Laboratory Techniques," "Measurement, Control and Automation Techniques," "Structural Materials," "Works Techniques," and the special sections "Pumps and Fittings," and "Packaging Techniques."

In each of these fields lectures were given on selected topics, followed by discussion. In addition there was a series of talks before senior students in conjunction with practical exercises designed to familiarise the listeners with certain specialised apparatus. Altogether the number of such lectures exceeded 100. Visits also took place to twenty-five firms in the Frankfurt area, mostly chemical and instrument works. Twenty-nine works films and scientific documentaries were shown at the exhibition cinema.

Opening Ceremony

On Saturday, May 31, participants in the European Chemical Engineering Congress and the 1958 Achema were welcomed by Chief Burgomaster, Werner Bockelmann, on behalf of the city of Frankfurt, and by the Prime Minister of Hesse, Dr. Georg-August Zinn. In his speech before the meeting, Professor Dr. Edy Velander, director of the Royal Swedish Academy of Engineering Sciences, referred to what he called "vertical specialists"—those specialising in increasingly narrow fields of science and technology. Their work demanded the co-operation, if it were not to remain isolated and sterile, of those "human catalysts," the "horizontal specialists," who covered many fields of science in special applications such as instrumentation, automatic control, operational research, and so on. The knowledge of such a specialist should not be the wider the thinner, like oil on water, but should consist of a small number of peaks in narrow fields. There were no university courses for such people, but no better opportunity could be designed for them to broaden their spectrum than attendance at the present exhibition.

Professor Dr. Carl Wurster, Ludwigshafen, president of the Gesellschaft Deutscher Chemiker, in his address, raised the question, which he admitted was a difficult one, of striking a balance between the optimum size of a congress such as the Achema and optimum effectiveness. In any case, the usefulness of "discussion in front of the object" between maker and user, as afforded by the present exhibition, was undoubtedly very great, particularly to chemists, with their mental habit of picturing the abstract in terms of concrete models. He was happy to see the announced participation of many experts from Germany and abroad in the European Corrosion Congress, which had been prepared by the German Bunsen-Society for Physical Chemistry, together with the Gesellschaft Deutscher Chemiker.

The President of the Chemical Industries' Federation, Professor Dr. Ulrich Haberland, Leverkusen, in his speech, referred to the need of industry for an adequate market. The chemical industry was in favour of the Common Market and the Free Trade Area, but considered that the ultimate objective would have to be a unified world market. International division of

labour and international co-operation, only in their beginnings as far as economics was concerned, had already been realised in a wider and better sense by science and technology. "Electronic Computation in Science, Technology and Economics" was the title of Professor D.Ph. Ludwig Biermann's address. Mechanical computation was the counterpart to automation in production. Its chief importance to technology and economics probably lay in the continuing spread of mathematical methods in those fields.

Second Congress of Chemical Engineering

The European Federation of Chemical Engineering was founded in Paris in 1953 and held its first congress in Frankfurt in connection with the 1955 Achema. The Second Congress opened in Brussels on May 28; on that day three plenary lectures were given, the first by Professor Eugène Mertens de Wilmars, director of the Institut de Chimie Industrielle and of the Institut du Genie Chimique of the University of Louvain, on the theme "Modern Aspects of the Calculation of Reactors." The chemical reactor occupies a key position in the chain of chemical production for it is in the reactor that the basic operation of manufacture is effected. The lecturer discussed the aims and scope of reactor research and design, taking as examples gaseous and liquid phase reactors.

The second plenary lecture was given by Monsieur Pierre Baar, manager of the Section "Etudes et Entreprises" of the Société Belge de l'Azote et des Produits Chimiques, of Marly, who spoke about "The role of the Projecting Department in Chemical Engineering." In the final lecture of the day Monsieur André Macq, chief consultant on chemical engineering and development to the Union Chimique Belge, dealt with the topic "Industry and the Choice of a Process," discussing the many factors which require consideration when a new process is to be installed in order that it should yield a good margin of profit over a reasonably long period.

The second day of the Brussels meeting was devoted to sightseeing, in particular to a visit to the International and Universal Exhibition at the Heysel where, in the Chemistry Pavilion of the Belgian Section, heavy chemicals, pharmaceuticals, and dyestuffs were on display.

On May 31, the congress was reconvened in Frankfurt-on-Main where during the following days the main business was transacted, comprising six plenary and sixty-nine discussion lectures.

The plenary lectures were given on June 1, 2 and 3. Speaking about "Changes in Chemical Technology since 1945," Professor P. Baumann, Marl, referred in particular to petrochemistry and automation, illustrating the differences and similarities which exist in these fields, between the U.S.A. and Western Europe. Professor Dr. E. Velander, Stockholm, spoke about "Problems of Automation in Chemical Technology." Automatic control was necessitated by the increasing complexity of chemical processes which could no longer be effectively guided and co-ordinated by human control. This gave rise to new problems, mainly in connection with the combined action of several control systems, starting and stopping, and the choice of alternatives by the controlling electronic computer. One difficulty in the way of automation was that it demanded much longer trouble-free operation of the computer than could at present be guaranteed. Other problems, more on the human side, arose from the required co-operation of specialists from many widely different fields.

Dr. W. Idris Jones, London, in his lecture "Recent Developments in the Thermal Treatment of Coal," mentioned the need for new processes to manufacture smokeless domestic fuel from non-coking kinds of bituminous coal. He described the use of a fluidised bed to heat-treat powdered coal which was subsequently briquetted while still hot, and the design of a suitable reactor. The coke obtained was suitable for chemical and metallurgical purposes.

Professor Donald F. Othmer, New York, discussed "Acetic Acid Recovery Methods," such as azeotropic distillation, extractive distillation, and liquid-liquid extraction. These methods, which were first developed in connection with acetic acid production, process recovery and effluent treatment have since been introduced in other processes in chemical and petroleum engineering. From the neutral and alkaline cellulose process, amounts of acetic acid sufficient for the whole of industry could be reclaimed and the pollution of rivers would be lessened.

"Progress with the Control of Technical Reactions" was the subject of Professor Dr. D. W. van Krevelen, Limburg, who dealt with the relation of process characteristics, characteristic quantities, and the diagrammatic representation of the latter. Non-reversible processes were studied by means of simplified models. For homogeneous systems, solutions had been obtained for most isothermal cases which allowed the size of the process to be scaled up. More recently the influence of such factors as mixing times, diffusion and time of transit had been studied. Even greater complexities arose with heterogeneous systems, a study of which was still in its beginnings, although important progress had been made in the case of some quasi-homogeneous reactions.

Monsieur Jean Eudes, Paris, dealt with "The Separation of Plutonium from the Irradiated Uranium of Atomic Reactors," with special reference to the process employed at the Marcoule plant (treatment of dilute solutions of the nitrates with tributyl phosphate as a selective solvent, followed by purification by means of ion exchange resins). The plant must function with extreme reliability, and the lecturerer described the process and the safety and control measures employed.

The discussion lectures, which formed the main part of the congress, will now be summarised briefly. They may conveniently be grouped under the headings which follow.

Basic Research.—A. Lydersen, Trondheim, speaking about "The Estimation of Physical Constants of Materials with the Help of General Methods," showed that enthalpy, equilibrium constants, and transport numbers could be derived from general equations by analogy with the theorem of corresponding states. "Transport Phenomena in the Temperature Region up to 1100 deg. Cent." was the subject of K. Schaefer, Heidelberg, who reported on thermal conductivity measurements of CO, CH_4, N_2 and A by means of an extension of Schleiermacher's method, with conclusions regarding diffusion at such temperatures. H. Ziebland, Waltham Abbey, dealt with "The Thermal Conductivity of Nitrogen, Oxygen and Argon in the Liquid and Gas States," measured by the cylindrical annulus method between −190 deg. and −80 deg. Cent.

H. J. Oel and A. Srinivasan, in a lecture delivered by H. J. Oel on "The role of Boundary Phases in the Transport of Matter by Diffusion," referred to a special kind of resistance at the phase boundaries between an aqueous solution of bromine and the air. "Exchange Velocity and Energy During Absorption and Extraction" formed the theme of a talk by F. Kneule, Munich. S. Koncar-Djurdjevic delivered the lecture "Determination of Boundary Layer Thickness by the Adsorption Method," of which he is joint author together with G. Popovic and A. Kiseljeva, Belgrade. The adsorption of colour on a solid surface from a flowing liquid gives information concerning the boundary layer. J. Schnautz, Darmstadt, in "The Effect of Turbulence Intensity on Mass Transfer Processes," dealt with changes in shape of naphthalene models due to sublimation in an air current, which indicate the flow near the surface. Edith Straubel-Fischer, Freiberg, lectured on "The Influence of External Electric Fields on the Domain Structure of Seignette Salt." In alternating electric fields a movement of domains in resonance with the field can be recognised.

H. Glaser, Göttingen, reported on turbulence created by obstacles and flow conditions in layers of sprayed Raschig rings. Three regimes may be distinguished, according to whether the gas current permits a laminar flow of the liquid, causes turbulence or even causes the liquid to build up. Heat flow from a platinum wire immersed in a nearly boiling two-component liquid was measured by S. J. D. van Stralen and W. R. van Wijk, Wageningen, as a function of composition, in the range 100mm Hg to 20 atmospheres. Heat transfer to a suspension through which gas was being bubbled was investigated by H. Kölbel and E. Borchers, Berlin-Charlottenburg. K. Dieter, Karlsruhe, reported local transfer coefficients of film evaporators, obtained by means of thermocouples embedded in the wall of the evaporator. The plate evaporator was the subject of a paper by G. A. Dummett, Crawley. By mixing peat with polar oils a separation of up to 80 per cent of the water becomes possible, stated E. Weingaertner, Bangalore.

J. Danze, L. Delvaux and E. Buchet, Liège, reported on the optimal arrangement of the radiators in an infra-red drying plant. F. Patat and H. Langemann, Munich, dealing with the kinetics of the grinding process, state that there was no analogy between chemical kinetics and grinding, the progress of which with time could be described over finite regions in terms of a physically meaningful reaction speed which depended on the prevailing conditions. The power of adhesion and angle of repose of powders were investigated in a paper by F. Patat and W. Schmid, Munich, who found a difference between the adhesive power of single particles and of larger quantities of particles.

F. Langers and F. Grein, Göttingen, investigated packed towers with three kinds of packings, at low throughputs of 1 to 400 cubic centimetres per hour. J. J. Martin, R. D. Sheen and H. C. Shiung, Ann Arbor, Michigan, extended the vapour pressure equations by adding a fifth term. This theoretically justified step is stated to extend the validity of the equation to the vicinity of the critical point. From the vibrations of droplets suspended in an alternating field the speed of evaporation was deducted by H. Straubel, Freiberg. With crystals, the method permits the measurement of a change of the electric charge due, e.g. to photoelectricity or radioactivity, which effects can thus be measured.

Extraction and Desalting.—S. G. Terjesen, Trondheim, ascribed the reduction in material transfer through a liquid boundary which was experienced by surface-active substances, to a change in the flow near the boundary. F. H. Garner, Birmingham, described an impeller-agitated perforated-plate column, which, with the partially miscible system methyl isobutyl ketone-diethylamine water, showed an increase of stage efficiency from 20 to 70 per cent when agitated. Liquid-liquid extraction with Podbienak machines was described by F. H. Becker-Boost, Bochum. Nadine Isaac and Raf de Witte, Brussels, presented a paper on a novel plate extractor with vibrating plate, used in the separation of zirconium and hafnium. W. Siemens and W. Weiss, Berlin-Charlottenburg, suggested the use in calculations on bubble columns of a mixing coefficient, by analogy with the diffusion coefficient. J. Admiraal, Maarn, dealt with demineralisation by ion exchange in the practice of Germany, the Netherlands, the U.S.A. and Belgium. Electro-dialysis was used to produce 18 cubic metres per hour of fresh water from salt water, in a plant described by E. Wegelin, The Hague.

Fluidised Beds and Filtration.—Labelling of solids and gases with radioisotopes for the purpose of measuring the mixing effect in chemically reacting fluidised beds was described by W. G. May, Linden, N.J. A statistical model of the fluid flow through stationary or moving solid beds (Re=30 to 40), was described by H.-G. Kayser, Berlin-Charlottenburg. A paper by D. C. Freshwater and N. J. Hassett, Loughborough, dealt with density differences in the up and downgoing streams of a fluidised bed, preferential settling-out towards the walls, and the co-existence of a fluidised and a non-fluidised layer. A. F. Orlicek, Vienna, reported on radioactive tracer experiments in connection with filtration. A. H. de Haas van Dorsser, The Hague, described the development at the T.N.O. Central Technical Institute of an electrostatic filter in which the efficiency was increased from the usual 97 to 99 per cent and the volume reduced by 90 per cent, by the addition of moisture. Separation of suspension at 10 atm. and up to 180 deg. Cent. has been made possible by a new design of centrifuge and hydrocyclone, according to H. Trawinski, Wiesbaden.

(*To be continued*)

International Gas Turbine Congress

AN International Meeting on Gas Turbines, organised by the Polytechnic Faculty of Mons, took place at Mons, Belgium, during the period June 4 to 6. Besides affording the participants an opportunity to exchange views on a subject of growing importance, the congress heard several lectures dealing with a number of aspects of gas turbine design and operation. In what follows we shall summarise these talks, the complete text of which is due to be published later this year in the *Revue M* of the Société Belge des Mécaniciens, rue des Drapiers 21, Brussels.

On the opening day, Monsieur L. R. Beduwe, general manager in charge of production of the "Union des Centrales Electriques Industrielles," and Professor A. L. Jaumotte, of Brussels University, and president of the Société Belge des Mécaniciens, spoke to the theme, "The Scope of the Gas Turbine in Industries Generating Their Own Gas Supply." The authors briefly reviewed the present state of gas turbine technology in respect of maximum temperatures, efficiency and output for the principal circuits. After comparing, from the user's point of view, natural gas, gas oil, heavy fuel oils, and blast-furnace gas, the lecturers showed the growth in output of industrial turbines working on blast-furnace gas on the one hand, and on heavy fuel oils with or without additives, on the other. In conclusion, a description was given of present applications of the gas turbine by producer-consumers of gas in various industries, in particular in connection with the production of iron and steel.

"The Use of Gas Turbines to Supply Peak Power in the Power Station of Electricité de France" was the title of Dr.-Ing. P. Chambadal's lecture. Dr. Chambadal, who is the director of research and technical planning of the E.d.F., advocated the use of open-circuit turbines, without heat exchanger, on gas turbines supplied by free piston gas generators, or equipped with a rotary compressor. A programme along these lines has been partially completed. It includes five sets each of 6MW and comprising a gas turbine connected to a synchronous generator by a coupling which can be operated during running. One of the turbines is supplied by eight free piston gas generators; another, by six free piston generators followed by a combustion chamber. The last three turbines, which are by different makers, are fitted with rotary compressors. Besides describing the installations, the paper gave details of the performance of those sets which have already been put into service.

Dr. C. Keller, research director of Escher Wyss, Ltd., Zürich, discussed the possibilities of the gas turbine in connection with atomic power, as studied in the U.S.A., Great Britain, and Switzerland, during the last two years. It was likely that such nuclear stations would be put into service during the coming ten to fifteen years. Pilot projects already existed in the U.S.A. and U.K. It was a question of developing fuel elements and machines which would withstand working temperatures above 600 deg. Cent. Escher Wyss and its licensees had studied the application in this field of the steam turbine and at the same time that of the closed cycle gas turbine. The last-mentioned arrangement seemed possible for medium-size turbo-sets between 2MW and 60MW. Oil- and coal-fired gas turbines of this kind had already been built by his firm. Applying gas turbines to nuclear stations which at present operated with saturated low-pressure steam would increase the efficiency. Design projects had also been carried out for atomic reactors fitted with gas turbines, for stationary, marine and aeronautical purposes. Some of these were described by the lecturer, who surveyed the present-day state of design knowledge in the atomic energy field.

Monsieur E. Aguet, chief engineer of Sulzer Bros., Ltd., Winterthur, spoke about "The Gas Turbine in the Iron and Steel Industry." The speaker illustrated his remarks by a list of completed installations and installations on order. The main applications were to variable-speed blowers, production of compressed air, constant speed generators, and mixed blower-generator sets. After dealing with the characteristics of the machines and the methods of speed control, the lecturer described some typical designs, and also dealt with double-fuel operation, exhaust boilers, and industrial operating experiences. Finally, Monsieur Aguet discussed the prospects of increasing the thermal efficiency, using the exhaust heat in Cowper stoves, or by combining the reheating stoves with the turbine in the form of metallic heat exchangers.

In his talk, "Operating Experience with Ruston and Hornsby Gas Turbines," Mr. G. B. R. Feilden, Engineering Director of Ruston and Hornsby, Ltd., Lincoln, recalled that preliminary work on the design for the Ruston and Hornsby 750kW recuperative gas turbine was begun in 1945, and a separate section to handle this work was set up in May, 1946. The first prototype machine ran three years later and gave very nearly its predicted performance from the outset, a full load brake thermal efficiency of 23·4 per cent being achieved, with a slightly higher gas temperature than the design figure.

After the success of the prototype machine, the company decided to introduce a production design which followed the basic aerodynamics and thermodynamics of the prototype very closely, but incorporated a number of mechanical changes which increased the versatility of the set in application. The first units of this design were sold in 1950 and orders for the machine, in both recuperative and non-recuperative form, had been received at an increasing rate. In February, 1958, the total number of orders for the 750–1000kW "TA" turbine amounted to eighty-one, of which forty were now in service, burning fuels ranging from natural gas to crude oil and coal tar fuel. These remarks were followed by a detailed account of the operating experience obtained with a number of representative installations, including that at the refinery of Azienda Generale Italiana Petroli at Cortemaggiore (Italy), where the total running time since the set was installed in July, 1955, now exceeds 20,000 hours and includes a non-stop run of 6000 hours. As another example, the performance of the turbine installed at No. 11 Gathering Centre of the Kuwait Oil Company may be cited, this set having run over 9000 hours without requiring any major maintenance attention, or even the cleaning of the compressor blading, notwithstanding the frequent occurrence of dust storms at certain times of the year. The paper concluded with a reference to the performance of Ruston gas turbines operating in conjunction with waste heat recovery equipment, and a review of the trend of development.

Mr. W. Tipler, Senior Engineer of Shell Petroleum Company, Ltd., London, spoke about "The Present Position and Future Prospects Concerning the use of Residual Fuel Oils in Gas Turbines."

The use of a single combustion chamber was now considered desirable for industrial and marine gas turbines on account of the greater reliability thereby achieved, particularly when burning residual fuel oils. However, this choice implied that the volume of the combustion system was larger than that of a multiple chamber system, and in units of more than about 4000kW output the size of the combustion chamber might produce difficulties for the engine designer. This problem had been overcome by the use of "multi-head" chambers in which the fuel flow is divided between a number of atomisers each equipped with its own air director. All the atomisers fire into a common flame zone as in boiler practice. The paper described the main design features of combustion chambers of this type, and compared their performance with those of conventional chambers for similar duties.

Although many fundamental data on combustion processes were lacking, the design of combustion systems for gas turbines of any size to operate on any grade of fuel oil could now be undertaken with confidence. In contrast, if the fuel oil contained a significant residual component the operation of the unit might be handicapped by the effects of fuel oil ash deposition and corrosion on the turbine blading. This subject and the use of fuel oil additives had been discussed in many papers, but the past year had produced little new information. The operation of the Liberty Ship "John Sergeant" was of little interest due to the abnormally low ash contents of the fuels so far used. It was expected that the gas turbine tanker "Auris" would yield further useful results in the near future; as with her predecessor, her new engine had been designed for use with normal grades of fuel oil available at all bunker ports. The recently published results of the General Electric Company (U.S.A.) were of great interest and would be discussed in more detail.

In general, the use of residual fuel oils on high temperature gas turbines (maximum turbine inlet temperature above 650 deg. Cent.) could not be approached with confidence due to the possibility of accelerated blade corrosion, and ash deposition might cause difficulties below this limit. Certain manufacturers had attempted to alleviate these troubles by suggesting limiting fuel oil ash specifications. These specifications conflicted in their requirements, and the distribution of fuels conforming to these varying stipulations would reduce the availability and increase the price of the fuel.

Certain manufacturers were now building high temperature gas turbines using cooled turbine components. Few data were available concerning the effects of fuel oil ash under these conditions; from boiler experience and theoretical considerations, ash deposition might still occur, but blade corrosion should be eliminated if the metal temperature were maintained below 650 deg. Cent.

From experience so far available from free piston engines and turbocharged diesel engines operating on residual fuel oils, it was apparent that fuel oil ash effects (or their absence) agreed with gas turbine experience under similar temperature conditions.

"Gas Turbines for Small Outputs" was the subject of a lecture by Monsieur J. Szydlowsky, president and general manager of S.A. Turbomeca, Bordes (B.P.), France. This firm's experience with high duty centrifugal compressors led to a study of small power turbines at a time when elsewhere the tendency towards larger and larger sizes had already established itself. The first turbine was the 100 h.p. "Oredon," built in 1948, which was quickly succeeded by the "Artouste I" of 250 h.p., "Artouste II" of 400 h.p., and "Artouste III" of 600 h.p. In parallel with this development there took place the construction of the power turbines and air compressors "Palouste." All these turbines have found application not only in aeronautics, but also in many other fields of engineering, often in competition with the reciprocating engine.

Messieurs R. Huber, technical director, and P. Szereszewski, engineer, of the Société d'Etudes Mécaniques et Energétiques (S.E.M.E.), France, spoke about some of the energy problems involved in the design of free piston gas generators, with particular reference to quick load changes in a set of gas generators used for supplying a turbine driving an electric generator.

"The Integration of the Gas Turbine Into Chemical Production Processes" was the theme of the lecture given by Monsieur F. Huber, chief engineer of Brown, Boveri et Cie A.G., Baden (Switzerland). The gas turbine, said the lecturer, found an application in the chemical industry in three ways. It could be used for the generation of electricity, or driving pumps or compressors, but the most interesting application was where the gas turbine cycle was directly connected with a chemical process the reactions of which took place under pressure. It was in this last case that one could truly speak about an integration with the chemical process.

The requirements in such cases differed greatly from those where the turbine was to be used for the production of power.

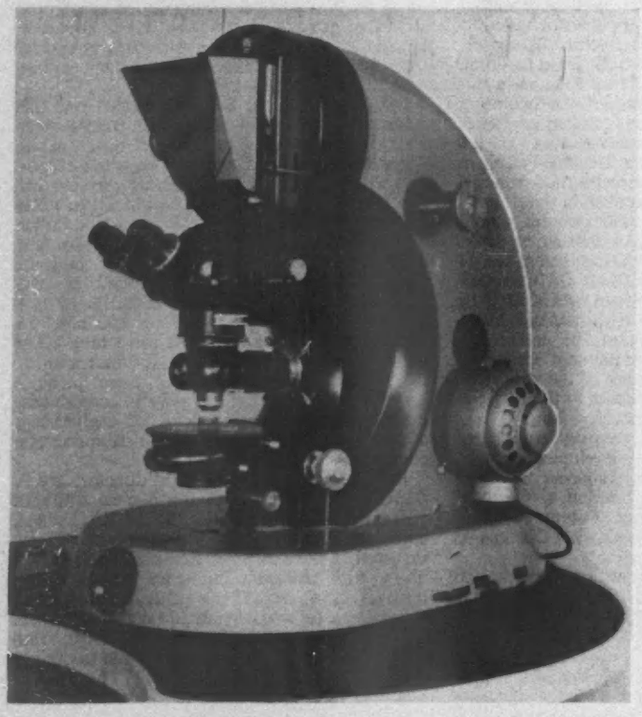
Because of the losses and low peak temperatures which occurred in the processes, as well as the modification of the delivery on account of

chemical processes which took place, the integrated gas turbine generally achieved only a very modest power output. Frequently it was even necessary to supply energy to it in order to keep it in operation. This extra energy one tried to obtain as much as possible in the form of heat abstracted at other points of the process, perhaps in the form of vapour. Thermal efficiency could not any longer be defined accurately but was, in effect, of secondary importance, much greater importance being placed on the reliability and performance of the machine with which the successful operation of the chemical process were closely connected.

The lecturer then described a number of such processes, in particular the Houdry process for the cracking of heavy oils which was introduced over twenty-five years ago, in which a gas turbine is used for the regeneration of a catalyst. Since this process was discontinuous it had been replaced by more modern methods, but the numerous sets in service were true precursors of the present-day gas turbines.

The manufacture of nitric acid opened up an important field of application for the integrated gas turbine. These processes, which used low and intermediate pressures, were many years old and gas turbines to supply them had been in use for over twenty years. At present, a large number of low and medium pressure installations using burnt ammonia were equipped with turbines which, however, resembled very little the classical power turbine.

The Zimmermann process for the burning of the "black liquor," residue from the manufacture of cellulose, is another interesting application now in course of being put into practical use. Here again the turbine was of rather special design, combustion taking place under a pressure of 150 atmospheres. The lecturer concluded his remarks by considering the economical factors applying to the use of integrated turbines.



The "Ultraphot II" combines microscope, camera and illumination apparatus in the same instrument, and is suited for viewing and photographing microscopic and macroscopic specimens

Automatic Camera Microscope

An automatic camera microscope of novel design has been installed at the Sheffield works of Padley and Venables, Ltd., makers of engineering cutting tools. Our illustration shows the instrument, of which there are as yet only three in this country. The "Ultraphot II" is made by Carl Zeiss, Oberkochen/Württemberg (agent: Degenhardt and Co., Ltd., 6, Cavendish Square, London, W.1). It is suited for visual observation and photography of microscopic and macroscopic specimens, combining microscope, camera and illumination apparatus in one and the same instrument. Besides high performances, the outstanding characteristics are ease of operation and the possibility of modifying the apparatus to meet the demands of all modern microscopic investigational techniques. Thus the bright field and dark field methods, and phase contrast technique with trans-illumination or epi-illumination employing polarised or non-polarised light are all readily applicable with this apparatus. In addition, it may also be used for microprojection on to ground glass plate. Change-over from one technique to another is simple, since the various accessories can be rapidly mounted.

Of particular interest is the fully automatic camera, which can also be employed for taking low power photographs. The intensity of specimen illumination may be varied so as to meet the most difficult problems (e.g. fluorescent light). Like all other main components of the instrument, the photo head of the camera is interchangeable and can be employed for photographs up to 9cm by 12cm on plates and flat film. The "Ultraphot II" is stated to be the first instrument embodying a photomicrographic camera provided with fully automatic exposure mechanism. As long as the microscopic image is in focus and the plate advancer is pulled out, it is only necessary to press a single push button to open the camera shutter. The exposure time is then adjusted automatically to the correct value, in dependence on the intensity of illumination, after which the shutter closes by itself. The length of the camera may be varied by 30cm by rotating a knob. Comprehensive survey photographs with photomicrographic objectives can be produced with specimens which will fit a field of up to 60mm diameter.

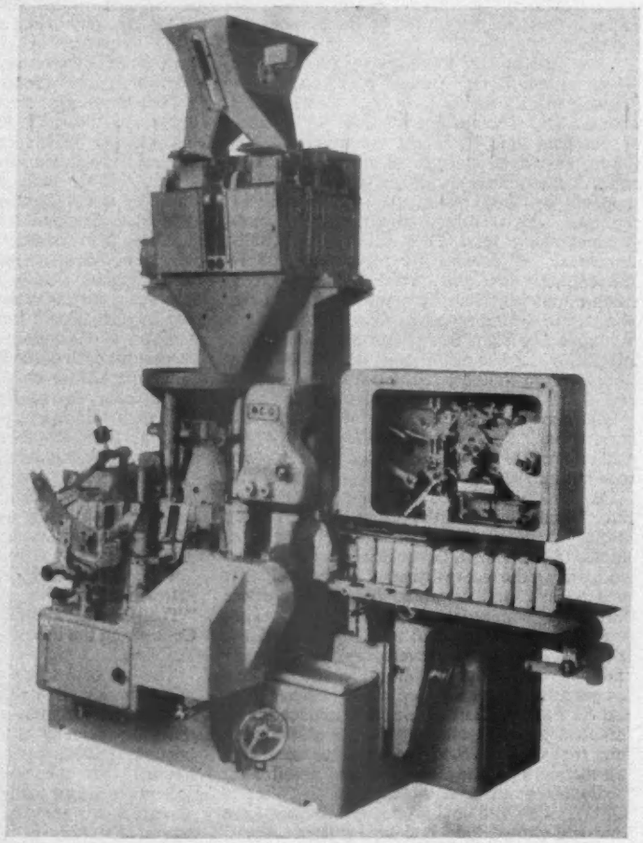
According to requirements, the instrument can be fitted with one, two or three lamps, which can be used, according to choice, for either trans-illumination or epi-illumination, or for combined trans-epi-illumination. The "Ultraphot II" is supplied with a specially constructed bench, built so as to give the apparatus a solid, vibration-free support while at the same time enabling the investigator to assume the most favourable and comfortable posture.

Automatic Packing Machine

In the accompanying illustration we show a machine for the opening, filling and closing of packages of sundry grocery goods, made by Swiss Industrial Company, Neuhausen (Rhine Falls), Switzerland. This machine, the model "BBS," is arranged for the packing of free-flowing products, such as sugar, coffee, rice, short-cut paste goods, or flour, into prefabricated bags (single, double or treble) of paper, or in transparent or aluminium-backed cellulose film. The bags may either be the gusset or the satchel type, such as are still being used for filling by hand. The machine is fitted with two precision fillers and weighers, the speed of operation being from thirty-five to forty packets a minute.

The work of the operating personnel is confined on the "BBS" machine to the filling of the bag magazine, the removal of the completed packets and general supervision. The product to be filled is brought to the hoppers of the weighing machines directly from silo, or another method of conveyance. The bags are sucked up from the stack, opened by a blower device and brought underneath the discharge tube. Before the discharge mechanism is actuated, a detector checks whether a bag is actually ready for filling.

The product is settled down by means of vibration under the discharge tube. The bag is thereupon conveyed to a closing device which, at the same time, shapes it on the two sides in order to give it regular form. Subsequently the open top of the bag is folded over and stuck down with sealing tape. The machine may be be fitted with an inking device in order to print the price and weight of the contents on the band, and also with an embossing stamp for code dating. The finished packets leave the machine on a conveyor belt. The model "BBS" may also be arranged for other methods of closure, such as heat-sealed erect top closure flaps; tin-tie closure; top end folded down flat, with or without a cardboard insert or picture picked up from stack, and also a heat-sealing end label from roll, or sift-proof, flat-folded top closure with end label from a roll.



Packing machine for free-flowing materials

Ten Years of Transistor Progress in the United States

BY OUR AMERICAN EDITOR

No. I

The invention of the transistor, which was announced by the Bell Telephone Laboratories, of New York, in June, 1948, gave birth to a new era in electrical technology now known as "semi-conductor electronics." The following decade saw an unprecedented expansion of this new technology until to-day almost half of the American development effort in electronics is devoted to semi-conductors. Furthermore, a rapidly increasing fraction of communications and other electronics apparatus now employs semi-conductor devices rather than thermionic valves as active components. To mark the tenth anniversary of the birth of the transistor, a semi-conductor conference was held at the Bell Telephone Laboratories on June 17, and this article, based on data released during the conference, reviews some of the work of the past decade.

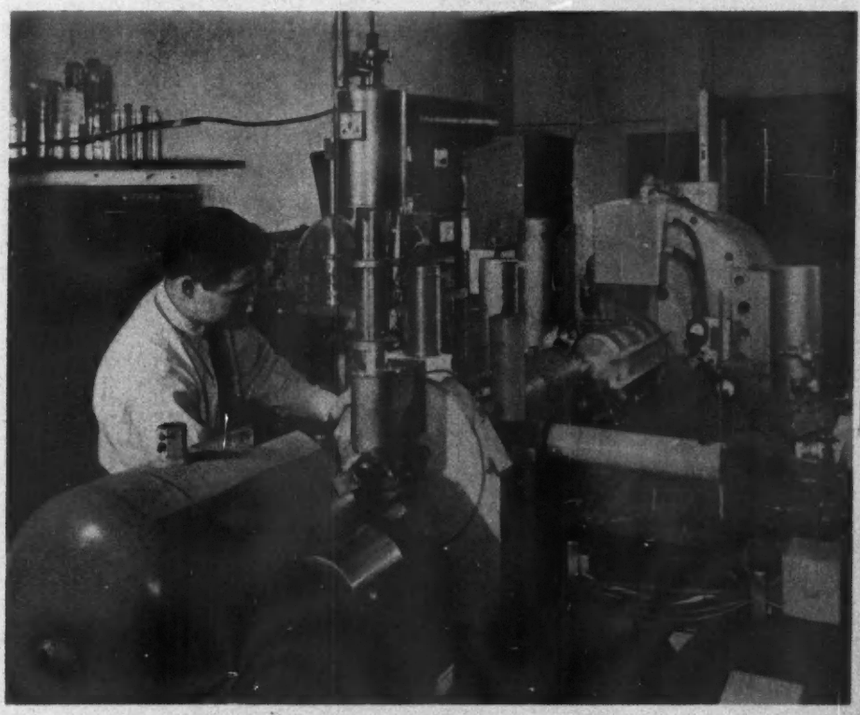


Fig. 1—Research work at the Bell Telephone Laboratories includes the study of defects in crystalline solids produced by this 1 MeV Van de Graaff linear accelerator

THE tenth anniversary of the discovery of the transistor effect by Bardeen, Brattain, and Shockley at the Bell Telephone Laboratories in June, 1948, was marked by a semi-conductor conference held at the laboratories in New Jersey on June 17. In his opening remarks to the conference, Dr. Mervin J. Kelly, President of the Bell Telephone Laboratories, stressed that transistor technology has so advanced in the last ten years that it is now technically possible for semi-conductors to do about 70 per cent of the work done by electron valves and tubes. The only immediate obstacle to the coming dominance of transistors and the closely related diodes was the present relatively high cost of manufacturing them so as to obtain high reliability and long life. He felt confident that further research and its application to these devices will result in lower costs. He estimated that in 1957 there were some 30,000,000 transistors and 60,000,000 semi-conductor diodes manufactured in the United States. The total value of these 90,000,000 semi-conductor units was well in excess of 100 million dollars. Some 600 transistor and 1300 diode types had been standardised and received industry codes by the end of 1957. It was predicted that the combined sales of transistors and diodes will reach a volume in excess of 500 million dollars by 1965. By 1975, transistors and diodes will care for perhaps 90 per cent of the active electronic device applications, while electron valves and tubes will serve the remaining 10 per cent.

The invention of the transistor at the Bell Telephone Laboratories initiated a completely new era in communications technology. All the transmission, switching, signalling, station and power systems employed in the telephone service of to-day will be affected by this invention. The transistor, a completely new oscillator, modulator and amplifier, gave early promise of large contributions to lower cost levels and to improved and new services. This promise justified the large research and development effort of the laboratories during the past ten years. The initial transistor invention resulted from a basic research programme carried out by a small team of scientists. The large rewards promised by this invention were at once recognised and led to a steady expansion and extension of effort until to-day almost one-third of the laboratories' work for the Bell System is devoted to building a new communications technology in which the transistor is the central element and applying it in the development of new facilities for communications.

The large rewards to service that were envisioned are made possible by the inherent properties of this new semi-conducting device. The principal ones are : (1) The availability of the electrons to meet the operating needs of transistors and diodes without the use of power to energise a hot cathode. The cathode power for the most generally used electron valves varies from 0·5W to 5·0W. (2) The low anode voltage required in the functioning of transistors and diodes. Anode potentials of 10V are frequent, while anode potentials of 50V are rare. Corresponding hot-cathode valves most frequently require anode potentials of 100V, while potentials as low as 50V are rare. (3) The miniature size of the transistor and diode. Their semi-conducting active element varies from the size of a pinhead to some five times this size. These active elements may be enclosed in containers varying in size from that of the smallest electron valve down to containers one-fifth that size. Their small size, low energy consumption and low anode potentials made it possible to associate them with components much smaller in size than those required by electron valves. (4) The scientifically possible indefinite life of the transistor and diode. The ideal transistor or diode does not deteriorate with use as do electron valves. While significant progress has been made in realising this ideal, much research and development must still be done before the goal of indefinite trouble-free life is attained. (5) Finally, when the technology has matured, the manufacturing cost of transistors and diodes should be well below the level of corresponding electron valves when produced in the same quantities.

Semi-Conductor Research

Prior to the last war, only a few people had ever seen a piece of germanium. It received its first real attention in the effort to develop better materials for microwave diodes, and at the end of the war polycrystalline germanium of high purity (by the standards of the day) was available. During a basic research study at the Bell Laboratories of the surface properties of this germanium, the transistor was invented, and on June 30, 1948, the model illustrated in Fig. 2 received its initial public display. The scientific importance of this work by Bardeen, Brattain and Shockley was recognised by the award of the 1956 Nobel Prize in Physics. The impact of the discovery on work at the laboratories was profound and almost immediate ; this was one invention that did not have to wait for appreciation. Within a few months, a sizeable group of people with diversified backgrounds was at work—physicists, chemists, metallurgists and engineers. Semiconductor research continued to increase, and it represents a major activity of the last decade.

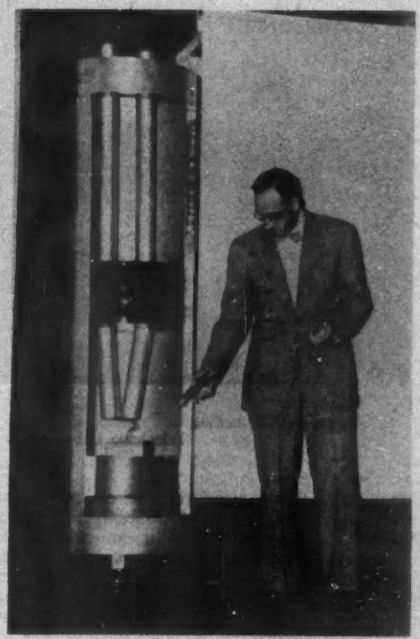


Fig. 2—Initial public display of transistor model in New York on June 30, 1948

With regard to the semi-conductor materials themselves, almost all of the effort has been put into germanium and silicon, in that order. This is surprising, since by conservative estimate there are at least a thousand semi-conducting substances. In hind-sight, it is fortunate that transistor action was first observed on germanium—it is one of the simplest of all solids. Greatly aided by this simplicity, steady and impressive progress has been made in understanding its properties. To-day, germanium is probably the most completely understood of all solid materials. Both germanium and silicon are now available as the purest and most perfectly formed crystals. Even more important, this purity and structural perfection can be altered in a controlled way by a number of techniques ; the electrical effects of these alterations are the distinguishing features of semi-conductors. The invention of zone melting and refining has removed most of the usual limitations of the purification of solids. The present problems are mostly concerned with recontamination from the vessels and chemicals used in the subsequent processing : this invention has such universal application that its importance transcends the semi-conductor field.

A detailed explanation of zone melting theory and practice may be found in the book " Zone Melting " by W. G. Pfann of the Bell Telephone Laboratories, published in April, 1958, by John Wiley and Sons, New York. Zone melting has important uses other than purification. It can distribute a desired impurity uniformly throughout a single crystal—a problem long unsolved. It can produce precisely controlled discontinuities in impurity concentration, such as the p-n or n-p-n junction in semi-conductors. It can do diverse jobs, such as joining, and can be used to measure diffusivities in liquids. In short, zone melting is a powerful new tool for manipulating impurities in crystals. The first important application of zone melting was to purify germanium for use in transistors, as shown in Figs. 3 and 4. Its success here was so spectacular that in short order it was widely adopted by transistor and diode manufacturers. Zone melting can be applied to many other materials. It works with any crystalline substance that can safely be melted and which exhibits a difference in impurity concentration between liquid and freezing solid.

The general term, zone melting, denotes a family of methods for controlling the distribution of soluble impurities (solutes) in crystalline materials. In all of these methods, a short molten zone travels slowly through a relatively long solid charge and, while travelling, redistributes the solutes in the charge. If the number, size and travel direction of the zones, as well as the initial make-up of the charge, are suitably chosen, many useful operations can be performed on the charge. A molten zone traversing an ingot has two liquid-solid interfaces—a melting interface and a freezing interface. The zone is able to redistribute impurities mainly because of what happens at the freezing interface. At the melting interface, solid material is merely melted and mixed with the contents of the zone—thrown into the hopper, so to speak. At the freezing interface, the solute concentration in the just-freezing solid generally differs from that in the liquid. If the solute lowers the melting point of the solvent, its concentration in the freezing solid will be lower than in the liquid. Hence, solute will be rejected by the freezing solid and will accumulate in the liquid. If the solute raises the melting point of the solvent, its concentration in the freezing solid will be greater than in the liquid and the liquid will be depleted of solute. Thus a freezing interface can reject certain solutes and attract others. The mechanism is closely akin to the basis of separation by fractional crystallisation. The main difference is that in zone melting part of a charge, rather than all of it, is melted at one time. This change has tremendously increased the efficiency of crystallisation as a separation technique and has led to new ways of using crystallisation.

Purification is probably the most important object of zone melting. The term zone refining designates zone-melting methods having this object. In zone refining a series of molten zones pass through the charge in one direction. Impurities travel with, or opposite to, the zones, depending on whether they lower or raise the melting point of the charge substance, respectively. They become concentrated in one or the other end of the charge, thereby purifying the remainder. The degree of separation increases with the number of passes, which is defined as the number of single zones which pass through the charge. The degree of separation approaches a limit as the number of passes becomes infinite. Zone refining can be used to concentrate desired impurities as well as to remove undesired ones. It can also be used in special circumstances as an analytical tool for detecting impurities unobservable by conventional techniques.

The merits of zone refining become evident when repeated crystallisations are desired. By using a series of closely spaced heaters a number of molten zones traverse the charge in a single operation. Separating pure from impure fractions, as in fractional crystallisation, is unnecessary. Eliminating this step of handling fractions is probably the chief advantage of zone refining. A second advantage is that time can be saved if the zones are close together, because succeeding crystallisations begin before the first one is complete. Other advantages arise from the small size of the molten region. Where contamination of the molten liquid by the container or the atmosphere is a problem, zone refining has the merit, as compared with fractional crystallisation, that a smaller proportion of the charge is liquid on the average. What might be called a physical advantage arises when container-free zone refining is necessary. Certain materials are so reactive when molten that no known container can hold them without contamination. Examples are silicon, titanium, zirconium and, to a lesser extent, iron. Several techniques of zone refining without a container have been developed to handle such materials. These have been possible because only a small part of the charge is molten at any one time. The most widely used is the floating zone technique, in which a molten zone is held in place by its own surface tension between two vertical co-linear rods. This method was first used with silicon, and is now used with other reactive metals.

As shown in Fig. 4, a vertical rod of silicon is supported at the top and bottom and the molten zone is formed between ; thus, the molten silicon is supported only by solid silicon. By this method, together with a specially developed chemical process for removing boron —an unfortunate example of one of the few cases where zone refining does not work efficiently—silicon has recently been prepared which surpasses even the best germanium in purity.

Single crystals may be grown by either variation of the zone-refining process by placing a seed crystal at one end and starting the molten zone where it will just touch the seed. The first successful method for producing single crystals was the pulling technique, where a seed is slowly

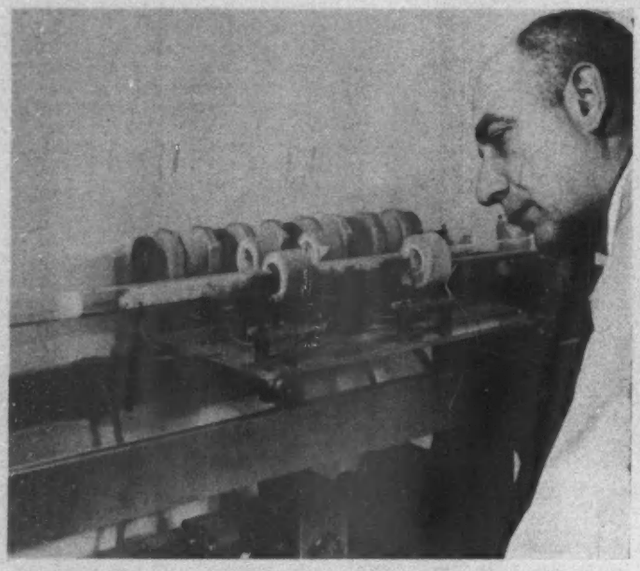


Fig. 3—Zone melting and refining apparatus developed at the Bell Telephone Laboratories

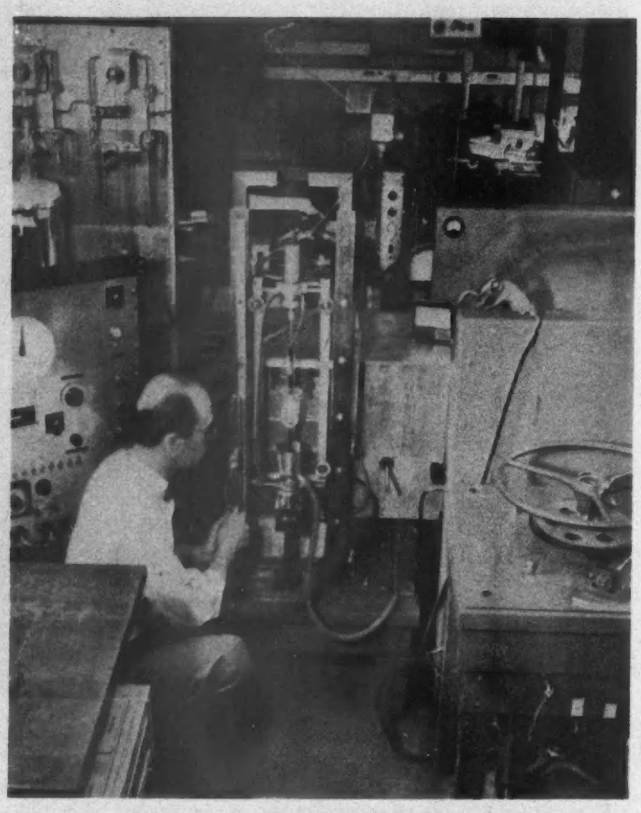


Fig. 4—Automatic floating zone melting and refining machine developed at the Bell Telephone Laboratories

pulled up after touching the surface of a melt. This method is still widely used for both silicon and germanium. Some of the best crystals produced by these methods have had dislocation densities as low as ten per square centimetre ; some areas large enough to study are apparently entirely free of dislocations. Most materials, in their best crystalline forms, have a million or more dislocations per square centimetre. The whole theory of dislocations in crystals was on quite tenuous grounds until the last few years. Experiments performed on germanium and silicon, in which dislocations were first definitely delineated and later produced under control, were invaluable in establishing the present sound position of the theory.

As better and better silicon and germanium became available, more accurate measurements were made of the known properties. One of the basic characteristics of a semi-conductor is the mobility of its charge carriers—i.e. its holes and electrons. Mobility is the speed with which a charge carrier moves in an electric field of 1V per centimetre. It was shown in a humorous graph in 1950 that the mobility of electrons in pure germanium, which should be a constant, actually gave a smooth, linearly increasing curve when plotted against the year of measurement in the interval 1945–50. There was nothing wrong with the measurements ; mobility is a structure-sensitive property, and measurements made after crystals of nearly perfect structure were available are in substantial agreement.

Many of the experiments now performed on semi-conductors rely on properties and ideas which were not known prior to the transistor. One of these is the injection of minority carriers in excess of their equilibrium numbers, which can be done in a controlled way with a forward-biased p–n junction. The trapping of electrons has been studied in this way. In some cases, where excess electrons and holes recombine through traps in silicon with the emission of radiation, a complete set of self-consistent data has been obtained. The traps have been identified chemically as ordinary donors and acceptors, and the wavelength of the radiation has been correlated with the independently measured electrical properties of the silicon crystal (the width of the forbidden energy gap) and the traps (their ionisation energy as donor or acceptor). As a final touch of elegance, it is found that one must include the proper absorption or emission of phonons in the crystal in order to achieve a precise energy balance. A phonon is a progressive wave of lattice vibrations of the crystal ; in this case the phonons and photons co-operate to conserve momentum as well as energy. The energy of the phonons is only about 5 per cent of the total energy involved.

One of the most interesting investigations has been that of the elementary processes of dielectric breakdown. In the localised fields of reverse-biased junctions, collision ionisation processes can be studied with great precision. It was found that true breakdown by avalanche multiplication occurred without damage to the crystal in both germanium and silicon. Another mechanism of breakdown, also non-destructive, has been observed under conditions somewhat more difficult to realise experimentally. This involves the creation of holes and electrons by internal field ionisation ; electrons are literally torn out of the crystal bonds. It is the first evidence of an effect predicted over twenty years ago, and is of considerable theoretical significance. In both instances, there is an emission of light from the breakdown region of the crystal. In the avalanche case, the light and breakdown current occur in separate spots. For breakdown by field emission, the light appears to come uniformly from relatively large areas of the crystal.

One of the most fruitful areas of semi-conductor research has been the study of surfaces. Surfaces have been historically one of the most difficult fields of study in both physics and chemistry. Their important properties are usually determined by fractional atom layers or at most a few atom layers of some foreign material that is extremely difficult to remove, identify or reproduce. For surface studies, semi-conductors offer the advantages that their electrical properties are influenced by small numbers of foreign atoms, and that there are many surface properties which may be measured on the same sample under the same conditions—surface photovoltage, photo-conductivity, surface recombination of holes and electrons, contact potential, and the modulation of conductivity by a surface field. The data of such experiments have been interpreted in terms of electronic surface states and reproducible results, which can be characterised with surface states of known electrical properties, have been obtained for several procedures of preparing the surface. For the most part however, the chemical nature of these surfaces is not known in detail.

The acousto-electric effect has recently been observed for the first time and in a germanium crystal. In this experiment, a standing sound wave is produced in the crystal. Since sound waves disturb the atoms of the crystal as they pass, standing waves produce periodic stresses in the crystal. There is a corresponding variation in the electrostatic potential within the crystal, and under certain conditions electrons tend to bunch slightly in some regions. The corresponding voltage fluctuation in the crystal is called the acousto-electric effect.

Chemical thermodynamics is especially suitable for application to dilute solutions—just the composition of greatest interest for semi-conductors. It has been shown that electrons and holes must be included as independent variables in the equilibrium considerations of semi-conductors. Thus, the solubility of lithium in germanium can be changed by several orders of magnitude merely by changing the number of conduction electrons in the germanium. This is a " common ion effect " familiar in chemistry ; it applies in this case because lithium ionises and contributes a conducting electron when it dissolves in germanium. Silicon is the most abundant element in the earth's crust, excepting oxygen, and it is therefore surprising that in 1948 there were almost no reliable thermodynamic data such as melting point, heat of fusion, volume change during fusion, and vapour pressure for either silicon or germanium. All of these have now been accurately measured.

Research work at the laboratories on devices themselves has also been intensive. It was a challenge to understand the original transistor and find better ways to make it. The rapidly evolving theory of p–n junctions, together with new techniques of crystal growth and impurity control, focused most of the attention on junction structures. The newly acquired understanding of semi-conductor p–n junctions was the most powerful single stimulant for the improvement and invention of transistors and related devices. A p–n junction is one of the least complicated structures possible in a semi-conductor. It is not unduly difficult to make, and it can be analysed mathematically in terms of straightforward semi-conductor ideas. It nevertheless embodies a remarkable set of useful properties. The injection of minority carriers has been mentioned ; this is the principal requirement of the emitter of a transistor. A reverse-biased p–n junction is a collector for minority carriers, a radiation detector, a means of creating space-charge layers with very high electric fields, and a voltage variable capacitance. An unbiased p–n junction is a rectifier, a photovoltaic element, and a sensitive thermo-electric couple. All of these features of p–n junctions have been used directly. They have also been employed to construct more complicated structures for other purposes. For example, one of the earliest ideas for a solid-state amplifier was to modulate the lateral conductivity of a thin sheet by changing the charge on the surface—much as a triode vacuum valve may be considered to operate by modulating the space current by changing the charge on the grid.

Many such structures were built, but none was successful because the electronic surface states mentioned above soaked up the charge and left the electrons within the sheet essentially unaffected. By putting a p–n junction on the surface of a germanium sheet, so that the space charge of the reverse-biased junction penetrated into the material, an amplifier was made which performed as predicted by a well-developed theory which included, of course, p–n junction principles. This device is called a field-effect transistor, although it is fundamentally different from junction and point-contact transistors. It is an example of a class of devices called unipolar transistors, in which only one kind of current carriers, holes or electrons, is involved in carrying a signal through. These devices have received relatively little attention so far, probably because the great potential of the versatile junction transistors has been so rapidly realised. Their characteristics are different from junction transistors, however, and they are likely to be properly evaluated in the future.

Another idea which originated in the early work on p–n junctions was to obtain a bistable structure which would exhibit either the high impedance characteristic of a reverse-biased junction or the low impedance of a forward-biased junction—depending on the imposed voltage. Such a device would be an electronic switch with enormous potentialities for massive applications in such places as telephone switching and computers. The p–n–p–n diode was invented for this purpose, again by extending and combining the ideas of simple p–n junctions. The first really successful high-frequency transistor, the germanium tetrode, was invented by realising through circuit considerations that the frequency limitations of junction transistors as then constructed was determined by the magnitude of the capacitances and resistances involved. These parameters were then made smaller by recourse to semi-conductor principles and the addition of a fourth electrode to decrease the active area of the emitter junction.

Device research is by no means confined to the theories of device operation. Of great importance is the creation of an improved technology, and research efforts have been most productive toward this end. Crystal growing and zone refining have been discussed. The first controlled p–n junctions were made when methods were found to change accurately the impurity balance in the melt during crystal growth. Some other examples are a staining technique to delineate p-type areas in a silicon crystal, a method for measuring accurately the thickness of surface layers which may be only one ten-thousandth of an inch thick, surface cleaning procedures, and a method for the " electroless " plating of nickel on silicon surfaces for use as contacts. The best example of an improved technique which evolved from research is solid-state diffusion. The diffusion constants and solid solubilities of donors and acceptors were being studied, and a troublesome stumbling block was contamination by uncontrolled impurities during the diffusions. This sometimes completely masked the effects under study. Several years were required to identify the contaminants and eliminate them. Ultimately, diffusion in both germanium and silicon was mastered and meant an improvement of about tenfold in the precision of placing impurities in the crystal. During the same interval, methods were being worked out for the preparation of even purer silicon. The Bell solar battery was the almost immediate product of these two advances in technology. It was known that p–n junctions are good photovoltaic cells, and the inventors of the solar battery calculated that the properties of silicon are almost ideally matched to the solar spectrum. Diffusion offered a practical means for making a structure designed to obtain optimum conversion of the absorbed light into electricity. Diffusion was next applied to reduce the critical dimensions of junction transistors, with a resultant increase of their high-frequency limit by about 100 times. It is now the preferred method for producing the intricate crystal compositions demanded by the newest semi-conductor devices.

The study of semi-conductors other than germanium and silicon is progressing and will certainly expand. Some of these substances are almost as simple as germanium and silicon, although their preparation is more difficult. Zinc oxide has been grown in small single crystals, and the electronic properties of several impurities determined. This material is a representative of another group of semi-conductors, more complicated than germanium and silicon in almost every way.

(To be continued)

Personal and Business

Appointments

MR. J. L. STURROCK has been appointed a director of E. Boydell and Co., Ltd.

MR. A. J. PEARSON has been appointed assistant general manager, London Midland Region of British Railways.

DR. PETER RODERICK has been appointed assistant chief metallurgist in the steel division of The Steel Company of Wales, Ltd.

MR. J. WALKER, A.M.I.E.E., has been appointed to a senior post in the engineering division of Sperry Gyroscope Company, Ltd.

DR. J. A. POPLE has been appointed superintendent of the newly created Basic Physics Division of the National Physical Laboratory.

SIR ALEXANDER SIM has been appointed chairman and director of Henley Foundries, Ltd., following the retirement of Sir John Dalton, M.I.E.E.

MR. W. W. JEACOCK has been appointed general manager of Coventry Gauge and Tool Company, Ltd., in succession to the late Mr. A. J. Hewitt.

MR. R. W. BUCKLE has been appointed deputy manager of the Hull depot of The Marconi International Marine Communication Company, Ltd.

MR. LESLIE L. HUGHES, A.M.I.E.E., has joined the technical staff of the Electrical Development Association as assistant to Mr. Philip Honey, A.M.I.E.E.

MR. J. RATTER, M.I.C.E., has been appointed a full-time member of the British Transport Commission, in succession to Sir Lansdale Train, who retires on September 30.

MR. P. H. N. ULANDER, M.I.Mech.E., F.Inst.F., has resigned his position as executive technical director of James Howden and Co., Ltd., but remains a director of the company.

MR. ERIC HOLLANDS has been appointed director and general manager of A.C.V. Sales, Ltd., in succession to Mr. A. S. C. Chattey who will retire from his active executive duties on August 1.

GUEST, KEEN AND NETTLEFOLDS, Ltd., announces that Sir Anthony Hugh Mostyn Bowlby, Bt., Mr. William Wallace Fea and Mr. William Allardyce Nicol have been appointed directors.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. W. E. C. Varley as assistant superintendent engineer, transmitters, on the retirement, after thirty-three years' service, of Mr. C. W. Skinner.

MR. A. F. BURKE has been elected president and Sir George Dowty vice-president, of the Society of British Aircraft Constructors. Mr. C. F. Uwins is deputy president and Sir Frederick Handley Page has been re-elected honorary treasurer.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., announces the following appointments in the newly-formed heavy plant division : Mr. I. A. Ferguson, manager, large electrical machine sales ; Mr. P. S. Clayton, manager, power rectifier sales ; Mr. J. B. Siddaway, manager, compressor sales.

INSTITUTION OF ELECTRICAL ENGINEERS, London Graduate and Student Section Committee has announced that the following officers have been elected for the 1958-59 session : Mr. J. F. Outram, chairman ; Mr. L. A. Harris, vice-chairman, and Mr. F. P. Harwood, honorary secretary.

JOHN LYSAGHT, Ltd., has announced the appointment of Mr. Edward Conner Lysaght as chairman in succession to Sir Charles Bruce-Gardner, Bt., who has retired as chairman and also from the board. Mr. William Allardyce Nicol has been appointed secretary and Mr. William Wallace Fea, chief accountant.

MR. R. SCHOLEY has been appointed superintendent of the Ickles departments of Steel, Peech and Tozer, a branch of the United Steel Companies, Ltd. He succeeds Mr. N. H. Bacon, who has retired after forty-seven years' service. Mr. D. R. Baker has been appointed assistant superintendent (technical) and Mr. D. B. Bray has been appointed manager of the heat treatment department.

VICKERS, Ltd., has announced the following changes in its organisation : Mr. R. P. H. Yapp has taken over the duties of director of finance of Vickers, Ltd., and Vickers-Armstrongs, Ltd., pending the retirement, owing to ill health, of Mr. E. J. Waddington ; Mr. B. L. Snow has been appointed sales manager and a special director of Vickers-Armstrongs (Engineers), Ltd., and has relinquished his appointment as sales director of George Mann and Co., Ltd. ; Mr. T. Wood has been appointed to the board of George Mann and Co., Ltd., as sales director.

THE CENTRAL ELECTRICITY GENERATING BOARD has announced the following appointments as assistant chief project engineers : Mr. W. B. Shannon, M.Inst.C.E., M.I.Mech.E., M.I.E.E., and Mr. W. H. C. Pilling, M.I.E.E., southern project group ; Mr. C. R. Watson Smyth, M.Inst.F., and Mr. B. C. Pyle, M.I.E.E., northern project group ; Mr. F. Barrell, M.I.Mech.E., M.I.E.E., and Mr. L. C. L. Dale, A.M.I.E.E., Midlands project group.

Business Announcements

TRIPLEX SAFETY GLASS COMPANY, Ltd. has changed its name to Triplex Holdings, Ltd.

THE MASSEY-FERGUSON organisation in Coventry states that its telephone number has been changed from Coventry 5533 to Coventry 75533.

MR. GEORGE ORMISTON, chief superintendent engineer, has retired from the New Zealand Shipping and Federal Steam Navigation Companies.

RANSOME AND MARLES BEARING COMPANY, Ltd., Newark-on-Trent, states that its Glasgow office is now situated at 380, Argyle Street, (telephone Central 3948).

PELAPONE ENGINES, Ltd., Slack Lane, Derby, states that the address of its sales division has been changed to 38/40, Bruton Street, London, W.1. (telephone Mayfair 2034).

LONDON TRANSPORT has announced that Mr. John Collins, generating station superintendent, Lots Road Generating Station, has retired after more than thirty-six years' service.

JOHN LYSAGHT, Ltd., states that the registered office of the company has been transferred from St. Vincents Works, Bristol, 2, to London Works, Smethwick, 40, Staffordshire.

MR. L. F. JEFFREY, M.Inst.C.E., M.I.Mech.E., M.I.E.E., controller of the East Midlands Division of the Central Electricity Generating Board, has retired on the advice of his doctors.

THE OWEN ORGANISATION states that the name of Hodgkiss Oil Burners, Ltd., Church Street, Wednesbury, Staffs (telephone Wednesbury 1081–2), has been changed to Rubery Owen (Heating), Ltd.

DORMAN AND SMITH, Ltd., states that on August 3, it will move its entire offices and works to a new factory at Atherton Works, Blackpool Road, Preston (telephone Preston 86785). The head offices of the associate company D. S. Plugs, Ltd., will also be moved to Preston, but the address of the works at Cumberland will remain unchanged,

J. AND J. NEIL (TEMPLE), Ltd., Temple Park Iron Works, Glasgow, W.3, has been appointed sole representative in Scotland for Bennis Combustion, Ltd., Bennis Mechanisations, Ltd., and Saxon Engineering Company, Ltd., The London office of Bennis Combustion, Ltd., Bennis Mechanisations, Ltd., and Saxon Engineering Company, Ltd., has been moved to Brettenham House, Lancaster Place, Strand, W.C.2 (telephone Covent Garden 2188–9).

PNEUMATIC SCALE (ENGLAND), Ltd., Vickers House, Broadway, Westminster, London, S.W.1, is a new company which has been formed by Pneumatic Scale Corporation, Ltd., Quincy, Mass, U.S.A., Vickers-Armstrongs (Engineers), Ltd., and Rockwell Machine Tool Company, Ltd., to manufacture in the United Kingdom and market throughout the world pneumatic scale equipment. The directors of the company are Mr. R. E. Huffam (chairman), Mr. K. Doble, Jr., Mr. J. G. Lloyd, Mr. C. E. Rockwell and Mr. R. Wonfor. The machines will be manufactured at the works of Vickers-Armstrongs (Engineers), Ltd., and sales will be carried out by Rockwell Pneumatic Scale, Ltd., Welsh Harp, Edgware Road, London, N.W.2.

Contracts

STEEL, PEECH AND TOZER, a branch of The United Steel Companies, Ltd., is to spend over £1,750,000 on the installation of a cold rolling mill and ancillary equipment adjacent to the Brinsworth continuous medium width hot strip mill. The new plant is planned to be in operation in two years' time.

DAVY AND UNITED ENGINEERING COMPANY, Ltd., has received an order from Northern Aluminium Company, Ltd., for a four-high breaking down and plate finishing mill plant for the Rogerstone Works. The principal unit to be built by Davy-United will be a 38in and 60in by 144in four-high rolling mill, which will be the first breaking down mill in the Rogerstone hot strip rolling line and will also be capable of producing finished heavy and light gauge plate. The mill will be capable of breaking down slab ingots weighing up to approximately 8 tons for plate up to 138in wide by ¼in minimum thickness. It will be driven by two 4000 h.p. motors, will have a top rolling speed of nearly 600ft per minute, and will be supplied along with a combined slab and plate shear.

SIMON-CARVES, Ltd., has received, through one of its subsidiary companies, Simon-Carves (Africa) (Pty.), Ltd., Johannesburg, an order valued at £400,000 for a pyrites-burning sulphuric acid plant to produce 120 short tons of acid a day. The plant will be built for the Harmony Gold Mining Company, Ltd., in the Orange Free State.

THE AIRSCREW COMPANY AND JICWOOD, Ltd., has received a contract for twelve steel industrial fans, the two largest weighing 2½ tons each and standing nearly 9ft high, for the United Kingdom Atomic Energy Authority and Spadeadam Rocket Research Establishment. The fans for the Spadeadam project are for use in plenum ventilating systems. Two input fans handling air volumes totalling 17,450 cubic feet per minute ordered for the Atomic Energy Authority will be used in a laboratory plenum system working in conjunction with a 17,450 cubic feet per minute fan extracting from fume cupboards.

Miscellanea

NINETEENTH INTERNATIONAL COMMERCIAL MOTOR TRANSPORT EXHIBITION.—The Commercial Motor Show staged every other year and organised by the Society of Motor Manufacturers and Traders, was last held in 1956. This year the Exhibition will run from Friday, September 26, until Saturday, October 4, from 10 a.m. to 9 p.m. daily (except Sunday, September 28). The official opening will be at 12 noon on September 26, and the ceremony will be performed by Mr. Harold Watkinson, Minister of Transport and Civil Aviation.

DYNAMOMETER FOR SMALL MACHINES.—A dynamometer of simple design now made by W. and F. Wills, Ltd., Bridgwater, Somerset, for testing small low-powered machines covers a speed range up to 1500 r.p.m. and up to 15 b.h.p. It can be run in clockwise or anti-clockwise directions and the applied loads can be varied during running. Loads are applied to the drum brakes through rams actuated by a simple hand-operated hydraulic system with reference to gauge marked in torque foot pounds. The brake drum is water cooled from a normal mains supply, where a pressure of 20-30 lb per square inch is available.

CONVERSION OF BRISTOL 170 FLEET.—Nine Bristol 170 aircraft are being flown by Air Charter, Ltd., on cross-Channel routes from Southend airport. Together with other members of the Press, we were recently shown how these machines are being converted from Mark 31 to Mark 32, using parts supplied by Bristol to modify the nose, dorsal fin and undercarriage, and how the interior of the aircraft is being furnished by the airline. The company's internal arrangement is said to permit interchange in forty minutes between capacities for sixteen seats plus three cars and twenty-four seats plus two cars : this is particularly useful on such runs as those to Ostend and Rotterdam. The new seats are in treble and single steel-framed units, and are cleared for 6 *g*. They are more attractive and comfortable than the old pattern, and weigh 15 lb apiece ; they are reported to be 10 lb lighter than the replaced seats. The converted aircraft are 39ft 6in long, compared with 33ft 6in previously, and the hold is 10ft longer at 42ft. The work has been done by Aviation Traders (Eng.), Ltd., a company associated with the airline.

QUALITY—ITS CREATION AND CONTROL.—A recent report published by the Institution of Production Engineers, entitled "Quality—Its Creation and Control," is designed to impart a new conception of the control of quality to higher management in industry in this country. The method described in the report is based upon the principle of operator control, whereby pride in workmanship on the part of operators is inculcated or encouraged, so that they take the initial responsibility for the quality of the product they produce to a comprehensive standard rather than a series of tolerance gauges. It is considered that the introduction of this form of operator control can result in improved product quality in the critical initial manufacturing stages to result in increased customer satisfaction and decreased scrap. To maintain the "quality consciousness" at all stages of manufacture, from design to actual piece part production, it is suggested that each concern should have a quality department—which would largely replace the work of the traditional inspection department which is concerned with quality after, rather than before, actual production.

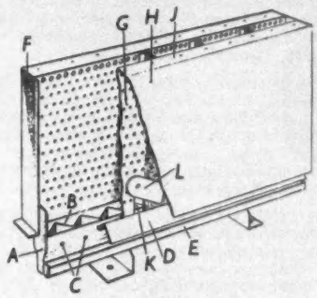
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in Italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

BURNERS AND SPRAYERS

796,803. August 13, 1956.—OIL BURNERS, Antonie Albertus Struijk, 130, Kamerlingh Onnesweg, Hilversum, Netherlands.

The invention concerns an oil burner whose operation is based on the burner itself forming a combustible mixture of vaporised liquid fuel and air. As illustrated in the drawing, the oil burner comprises an elongated rectangular oil reservoir *A* in which a zig-zag shaped metal strip *B* is arranged for promoting the vaporisation of the oil in the reservoir. In one of the longitudinal walls of the reservoir



No. 796,803

adjacent the upper edge there are perforations *C* above which a screening strip *D* is secured against the wall for covering a reservoir *E* for an ignition liquid, such as methylated spirit. On the oil reservoir *A* is a shell corresponding with the shape of the reservoir, which has closed end walls and double longitudinal walls. Each of the double longitudinal walls of the shell consists of a perforated wall *G* directed inwardly and welded to the corresponding longitudinal wall of the oil reservoir *A* and an outwardly directed closed wall *H* spaced from and running parallel to the perforated wall *G*. The bent upper edge *J* of wall *H* covers the space between the wall portions *G* and *H*. In one of the double walls is a passage *K* for igniting the oil burner, which passage can be opened and closed by a means *L* on the perforated wall *G*.—*June* 18, 1958.

INTERNAL COMBUSTION ENGINES

796,601. April 22, 1955.—ROTARY INTERNAL COMBUSTION ENGINES, Helmut Klormann, 69, Henricistrasse, Essen, Germany.

The invention relates to rotary internal combustion engines in which an annular power chamber is swept unidirectionally by a working piston. The object of the invention is to adapt a control rotary valve for application to rotary internal combustion engines. Referring to the drawing, a control rotary valve *A* is secured on a rotary shaft *B* and mounted in a housing *C*. The valve simultaneously controls two annular chambers *D* and *E*, rotors *G* and *F* in which, with pistons *H* and *J* secured to them, rotate simultaneously with the control valve. The hollow peripheral wall or skirt *K* of the control valve extends through slots *L* in the walls of the

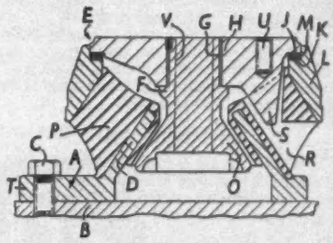
No. 796,601

annular chambers. The peripheral wall *K* is provided with a gap permitting through passage of piston *H* at a given instant and a second gap permitting through passage of piston *J* at another given instant. The annular cylinder *D* with its piston *H* operates in this construction as a compressor part, the gas to be compressed entering and passing through the rotor *F* in the direction of the arrow *M*. The compressed gas is simultaneously compressed by the leading face of the piston *H* through an opening *N* in the control valve in the direction of the arrow *O* into a space *P* serving as a combustion chamber. During rotation of the control valve through 180 deg., fuel supplied through the hollow shaft *R* can be injected into the combustion chamber *P* through a jet *S*. In the position *U* at which is disposed the aperture after approximately 180 deg. rotation of the rotary valve, the hot combustion gases escape from the combustion chamber and strike the piston *J* of the power stroke chamber *E* in the direction indicated by the arrow. At the same time, the exhaust gases are expelled through the rotor *G* by the leading face of the piston *J*. A gear drive system, not illustrated, ensuring synchronous operation of the two rotors is so connected with a pinion *T* on the shaft *R* that the control valve *A* rotates at the desired operating speed.—*June* 18, 1958.

BEARINGS AND SUPPORTS

796,231. November 8, 1955.—A VIBRATION ABSORBING MOUNTING, Metalastik, Ltd., Evington Valley Road, Leicester. (*Inventor: Archie John Hirst.*)

The object of the invention is to provide an improved means whereby the maximum relative deflection of the base and support members of a mounting is limited to a required value. More specifically to limit the relative deflection in both directions, i.e. in the direction of movement of the base and support members towards and away from one another. Three applications of the invention are described in the specification as well as the



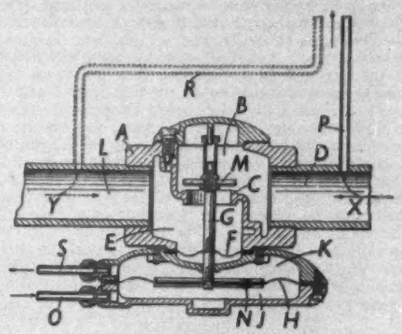
No. 796,231

modified design shown in the drawing herewith. As will be seen from the drawing, the base member *A* is attached to a foundation *B* by bolts *C* and comprises the frusto-conical ring *D*. The support member *E* comprises a column *F* threaded at *G* into a disc plate *H*, the peripheral edge *J* of which engages a step *K* of the frusto-conical ring *L*, shims *M* being inserted between edge and step to bring the plate *H* to a required height. The column has a frusto-conical nave *O* which lies within ring *D*. A ring *P* of rubber or like material is attached to ring *L* and ring *D* is embedded in ring *P*. The latter is provided with circumferentially spaced pockets *R*, into each of which a projection *S* of the disc plate *H* enters. The plate *H* is secured to the part to be supported either by bolts entering circumferentially spaced holes *U* or by a single control bolt entering hole *V*, though any other form of attachment may be used.—*June* 11, 1958.

VALVES

796,315. September 9, 1954.—RELAY CONTROL VALVE, Thomas De la Rue and Co., Ltd., Imperial House, 84-86, Regent Street, London, W.1. (*Inventor: Dennis Arthur Spencer.*)

The invention relates to relay valves for control systems for gas burning appliances, the object being to provide a construction of valve which will give complete safety when used in a control system for gas burning appliances such as described in the Specification No. 796,314. A further object of the invention is to provide a relay valve which, when used in conjunction with a thermostat can be adapted to give complete "on-off" control or to effect control at any intermediate position in accordance with the thermostat. Referring to the drawing, the valve comprises a casing *A* divided into upper, intermediate and lower compartments. The upper compartment *B* is defined by the top of the valve casing and a valve seating *C* and is in open communication with the main gas supply conduit *D*, which may be either the inlet or outlet conduit for the valve, depending on the manner in which the valve is connected in the gas control system. The intermediate compartment *E* is defined by the underside of the valve seating *C* and a flexible diaphragm *F*, referred to as the auxiliary diaphragm, which extends across the valve casing and is carried by a spindle *G* in slidable connection with the top of the valve casing in the upper compartment *B*. The lower end of the spindle, in the lower compartment, is secured to a weighted flexible diaphragm *H*, referred to as the main diaphragm, which extends across the lower compartment, dividing it into a lower diaphragm chamber *J* and an upper diaphragm chamber *K*. The intermediate compartment *E* is in open communication with the main gas supply conduit which, as in the case with the upper compartment *B*, may be either the inlet or outlet conduit, depending on the manner in which the relay valve is connected in the system. A valve element *M* on the spindle in the upper compartment *B* co-operates with the seating *C* to close the valve. The main diaphragm *H* has an orifice *N*, permitting communication between the lower and upper diaphragm chambers *J* and *K*. One end of a small bore weep conduit *O* is connected to the lower diaphragm chamber *J* and its other end is connected to the main gas supply conduit on one side of the relay valve, the chosen side being dependent



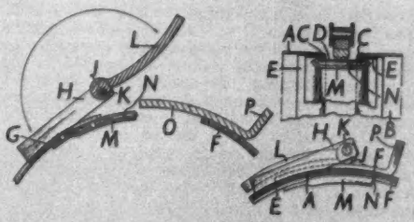
No. 796,315

on the manner in which the relay valve is to be connected in the gas control system. If the valve is so connected in the system that the gas flow is in the direction of the arrow *X*, the weep conduit will be connected to the main gas supply conduit on the right-hand side of the valve, as shown in the drawing, the weep conduit being indicated by *P*. However, if the valve connection in the control system is reversed so that the gas flow is in the direction of the arrow *Y*, the conduit will be connected to the main gas supply conduit on the left-hand side of the valve, as shown in the drawing by the dotted lines *R*. The weep conduit contains, in series, primary controls which are not shown. Gas which has passed through the weep conduit enters the lower diaphragm chamber *J* and passes by way of the orifice *N* to the upper diaphragm chamber *K*, whence it is evacuated to exhaust by way of an outlet vent conduit *S*. This vent leads the exhaust gas to a point adjacent the burner flame of the appliance where it is ignited. As long as the primary controls are open, gas pressure will build up beneath the main diaphragm *H* which will move up and, through the spindle *G*, valve element *M* will be lifted from its seat *C* so that the main gas supply can reach the burner of the appliance. In the event of any of the primary controls closing, gas will cease to flow through the weep conduit *P* or *R*, as the case may be, and gas remaining in the weep conduit will be vented by orifice *N* in the main diaphragm *H* and the outlet conduit *S* so that valve element *M* will close on to its seat under gravity through the weight of the main diaphragm *H*. The relay valve of the invention incorporates a number of safety features which ensure that no leakage of gas should occur in the event of the valve ceasing to function properly.—*June* 11, 1958.

MINING ENGINEERING

796,704. December 9, 1955.—JOINTS FOR FLEXIBLE-WALLED DUCTING, The Mining Engineering Company, Ltd., Meco Works, Worcester. (*Inventor: Angus Wellesley Duncan.*)

The invention relates to joints for connecting together lengths of ducting, such as are used for conveying air in the ventilation of mine workings. In the drawing are shown parts of adjacent ends *A* and *B* of two lengths of ducting and it will be seen



No. 796,704

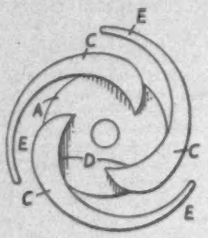
that the material of each end is folded back on itself over a bead *C*. These beads are of substantially inextensible flexible material such as flax. The jointing ring, a channel section steel strip *D*, has a substantially flat central base and two raised edge flanges *E* which engage behind the beads *C*. The

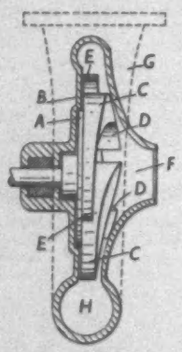
ring *D* is interrupted, the two ends being adjustably clamped together by means shown in the drawing. The two ends are shown at *E* and *F*. The end *E* has welded to it a channel section member *G* which has two arms *H* forming brackets between which an eccentric *J* is mounted for rotation on a pivot *K* by means of an operating handle *L*. A joggled support plate *M* is riveted to the underside of the end *E* and carries on its upper surface a rubber pad *N* against which the other end *F* can bed in the clamped position. This end carries a projecting tongue *O* with which is combined a handle *P*. The tongue *O* is designed to extend in between the arms *H* and to be engaged by the eccentric *J* so that the end *F* is pressed down on to the pad *N*, as shown in the left-hand view. The surface of the eccentric *J* and the upper surface of the tongue *O* are knurled so they tend to resist relative sliding. As a result of this, angular movement of the eccentric in a clamping direction urges the tongue away and thus urges the two ends *E* and *F* apart to expand the ring slightly immediately prior to final clamping. This is important in ensuring a good joint. In making a joint between two lengths of ducting, the ring is contracted by bringing the handles together so that the ends *E* and *F* overlap, enabling the inextensible beaded ends of the two lengths of ducting to be slipped over the raised edge flanges *E* and to lie in the base of the ring section. On the handles then being pulled apart to expand the ring, and the handle *L* being turned down against the outside of the ring, the two ends are clamped rigidly together.—*June* 18, 1958.

PUMPS

796,599. March 24, 1955.—CENTRIFUGAL PUMPS FOR LIQUIDS, Emil Julius Ask, 10, Finnerasgt, Haugesund, Norway.

The invention relates to centrifugal pumps for liquids and comprises an improved form of pump which achieves a high degree of efficiency by minimising turbulence in the liquid passages in the pump and which can be stopped for a period and then restarted without priming. Referring to the drawing, the pump impeller consists of a circular disc *A* mounted to rotate in a volute casing *B* and provided with three curved blades *C* which fit closely to the sides of the casing. The blades taper continuously





No. 796,599

from their leading end regions to their trailing ends. The inner surfaces *D* of the blades are so inclined from the centre of the pump impeller outwards that an evenly accelerating motion is imparted to the liquid being pumped. The inclination of the blades with respect to the radii of the impeller increases outwardly. The conduits are, to enable them always to be filled with liquid, formed of cross-section decreasing from the centre outwardly. Also, the cross-sections along the conduit are so chosen, in relation to the rate of flow of the liquid, that no unwanted high or low pressures will exist at any point in the conduits. This is achieved partly by making the walls of the casing *B* converge outwardly, as shown in the lower view, but also by shaping the blades *C* so that the distance measured from blade to blade across each of the passages between the blades decreases progressively towards the outlet end of the passage, as shown in the upper view. The convergence of the passages improves the self-priming property of the pump. The end regions *E* of the blades are, on their outer sides, so shaped that the liquid being pumped is, given a radial push as it leaves the pump impeller. The liquid is sucked through a central inlet *F* and is pumped under pressure through an outlet connecting piece *G* after first having passed through pump chamber *H*. The pump which is shown in the drawing illustrates the invention, but the design may be varied in many other ways without departing from the construction of the pump impeller and its mode of operation. The ends of the blades *C* are shown in the drawing as being rounded. However, the ends may be tapered to a sharp edge, further to reduce turbulence.—*June* 18, 1958.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

DRAWING INSTRUMENTS FOR DRAWING OFFICE USE

No. 1709 : 1958. Price 4s. 6d. This new British Standard combines in one volume, and supersedes, the previous editions of B.S. 1709 and B.S. 2460. "Drawing instruments," reads the Foreword to this fifteen page publication, "is a generic term referring to those instruments usually contained in a set or case of drawing instruments; it does not include such items as scales, set squares, tee squares and protractors, which are more correctly termed 'drawing office equipment.'" The first half of this standard specifies materials and certain important dimensions in respect of each of the instruments which make up a "full set." Requirements are now included for plated instruments. B.S. 1709 is one of the marks required to appear on each case; alternatively, the B.S.I.'s registered certification trade mark may be used—if the manufacturer is licensed to do so. The latter half of the publication is devoted to "Nomenclature of drawing instruments."

PIPE THREADS

No. 21 : 1957. Price 7s. 6d. In this standard, last revised in 1938, the text has been revised and extended to include illustrations and recommendations for gauging pipe threads, and tolerances for reference gauges.

The two kinds of pipe thread dealt with include those for joints made pressure-tight by the mating of the threads; and parallel external (longscrew) pipe threads where a pressure-tight joint is achieved by the compression of a soft material on to the surface of the external thread by tightening a back nut against a socket.

The B.S.P. size range is from ⅛in to 6in nominal bore inclusive, and the standard gives details of thread forms, dimensions and tolerances, together with the method of designating each type of thread.

CEMENT STANDARDS REVISED

No. 12 : 1958. Price 7s. 6d. No. 146 : 1958 Price 7s. 6d. No. 1370 : 1958. Price 8s. 6d. The reputation enjoyed by British cement throughout the world has, ever since 1904, been assured by British Standard 12: Portland Cement by which virtually all British production has been judged. The ninth revision of this standard has just been completed. Many detailed changes have been made to bring the standard up-to-date but the more important developments are the introduction of a standard concrete test, increases in the strength requirements, improvements in sampling and simplification of testing for setting time and soundness of the product. B.S.146, Portland Blast-Furnace Cement and B.S. 1370, Low Heat Portland Cement, have also been revised to incorporate the new tests and other modifications introduced in B.S. 12.

Hitherto, cement strength tests have been made on mortar, either as briquettes tested in tension or as cubes tested in compression. Both mortar tests require the use of a standard sand from one source only, and the results obtained must be carefully interpreted in order to assess the value of the cement in concrete. The new test involves making 4in cubes of concrete with specified amounts of cement and water, measured separately for each cube. The particular advantages of the new standard concrete test are that it permits the use of a wide range of aggregates, within certain specified limits, and that the cement is tested in the form in which it is generally used in practice, so that the results are of more direct value to engineers. The development of this standard concrete test is claimed to be an important advance in the field of cement and concrete technology and the value of the new British Standard should be increased accordingly.

The improved sampling clauses permit a user to sample a consignment of cement in as much detail as he wishes; previously he could obtain only an average sample for a given consignment, however large. The tests for setting times and soundness of cement are now much simplified by using one standard percentage addition of water for a given sample of cement. This modification has permitted the deletion of a table covering two pages of the earlier edition of the standard.

Launches and Trial Trips

CITY OF LANCASTER, cargo ship; built at the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., for Ellerman Lines, Ltd.; length between perpendiculars 405ft, breadth moulded 59ft, depth moulded to shelter deck 36ft 9in, load draught 24ft 6in, deadweight 7400 tons, service speed 14¼ knots; four holds, derricks to lift 7 tons and 10 tons, electric winches, three 180kW diesel-driven generators; Sulzer single-acting, two-stroke diesel engine, eight cylinders 720mm diameter by 1250mm stroke; 5040 b.h.p. at 121 r.p.m. Launch, May 5.

TRI-ELLIS, cargo-passenger ship; built at Govan by Harland and Wolff, Ltd., for The British Phosphate Commissioners; length between perpendiculars 486ft 3in, breadth moulded 68ft, depth moulded to shelter deck 40ft 6in, deadweight 13,950 tons, service speed 14 knots; two continuous decks, six holds, one 25-ton, two 10-ton and ten 5-ton derricks, electric winches; four 320kW diesel-driven generators; one Harland and Wolff two-stroke, single-acting, opposed piston diesel engine, seven cylinders 620mm diameter by 1870mm combined stroke, 112 r.p.m. Launch, May 15.

ROYAL DAFFODIL II, ferry; built by James Lamont and Co., Ltd., for the County Borough of Wallasey; length overall 159ft 6in, breadth at main deck 46ft, depth moulded 13ft 4in; there are main, promenade and sun decks; two 60kW generators; two Crossley single-acting, two-stroke oil engines, 1250 total b.h.p. Trial, May 15.

SCOTTISH QUEEN, trawler; built by John Lewis and Sons for Scottish Motor Trawlers, Ltd.; length between perpendiculars 115ft, breadth 25ft, depth 12ft; fishroom capacity 6000 cubic feet, electric trawl winch to take 1000 fathoms of 2¼in warp, 20kW generators; British Polar diesel engine, 640 b.h.p. at 250 r.p.m. Trial, May 15.

OVERSEAS PIONEER, oil tanker; built by the Furness Shipbuilding Company, Ltd., for London and Overseas Tankers, Ltd.; length between perpendiculars 560ft, breadth moulded 80ft, depth moulded 42ft 3in, deadweight 24,800 tons on 32ft 4in summer draught, speed 14½ knots; twenty-seven oil tanks, one main cargo pump room, three 1000 tons per hour turbine-driven centrifugal pumps, three 150 tons per hour vertical duplex stripping pumps; two 325kW turbo-generators, one 100kW diesel-driven generator; one set of Richardsons, Westgarth double reduction turbines, 7300 s.h.p. at 100 propeller r.p.m., two Foster-Wheeler "D" boilers supply steam at 450 lb per square inch and 750 deg. Fah. Launch, May 19.

CLAN MENZIES, cargo liner; built by The Greenock Dockyard Company, Ltd., for The Clan Line Steamers, Ltd.; length between perpendiculars 465ft, breadth moulded 65ft 6in, depth moulded 39ft 7½in, deadweight 9760 tons on 27ft 3in mean draught, gross tonnage 7800, service speed 16½ knots; twelve passengers; five cargo holds, bale capacity 572,000 cubic feet, one 80-ton, two 40-ton, two 15-ton, four 7-ton, ten 5-ton and two 3-ton derricks, electric winches; three 220kW diesel-driven generators; Wallsend-Doxford diaphragm opposed piston oil engine, six cylinders 750mm diameter by 2500mm combined stroke, arranged to burn heavy fuel, 7500 b.h.p. at 103 r.p.m. Trial, May 21.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

CHEMICAL SOCIETY

Mon. to Thurs., July 14 *to* 17.—The University, Hull, Symposium on "Steric Effects in Conjugated Systems."

Advanced Engineering Courses

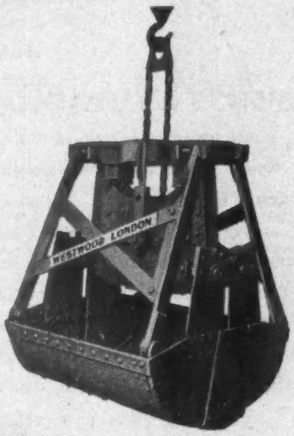
Applications of Computers. THE UNIVERSITY OF NOTTINGHAM, DEPARTMENT OF MECHANICAL ENGINEERING, University Park, Nottingham. One week's residential course. Monday to Friday, September 15 to 19. Course, including notes, ten guineas. Accommodation, eight guineas.

Graduate Course in Engineering Production. DEPARTMENT OF ENGINEERING PRODUCTION, The University, Edgbaston, Birmingham, 15. Post-graduate course of studies leading to the degree of Master of Science and to the Diploma for Graduate Studies in the Principles of Engineering Production and Management. Application for admission to the course, which lasts one year, should be submitted to the Registrar by July 30. Fee £95.

Graduate Course in Operational Research. DEPARTMENT OF ENGINEERING PRODUCTION, The University, Edgbaston, Birmingham, 15. Post-graduate course of studies leading to the degree of Master of Science in Operational Research Application for admission to the course, which lasts one year, should be submitted to the Registrar by July 30. Fee £95.

MECHANICAL GRABS

Illustrated is the Single Chain, self-dumping grab which is particularly suitable for handling coal, sand, ballast, etc.



Illustrated is the Twin Chain, Self-Dumping Grab which is particularly suitable for handling coal and similar materials where headroom is restricted.

JOSEPH WESTWOOD & CO. LTD.

Contractors to H.M. Government Departments. Crown Agents for the Colonies. British Railways (British Transport Commission), etc., etc. Bridge and Constructional Engineers, Manufacturers of Pressed Steel Troughing and Sheet Metal Equipment. Steel Stock Holders.

NAPIER YARD, MILLWALL, LONDON, E.14 *Tel: EASt 1043*

WESTWOODS

ESTABLISHED OVER 100 YEARS

George Wailes
AND COMPANY LIMITED

382-8 Euston Road, London, N.W.1.
Telephone: EUSTON 3176

Engineers · Millwrights & Tool Merchants

We are specialists in
EXPERIMENTAL WORK

SPECIAL MACHINES
DESIGNED AND MADE TO ORDER

MACHINING FOR THE TRADE

GENUINE PS STUBS SILVER STEEL

★ The best known brand in the world and the standard to which all other makers endeavour to work.

★ Accurate to .00025" for all sizes up to 1" diameter.

★ Supreme surface finish—a heritage of craftsmanship.

★ Made in 252 standard sizes—a size for every job to save machining costs.

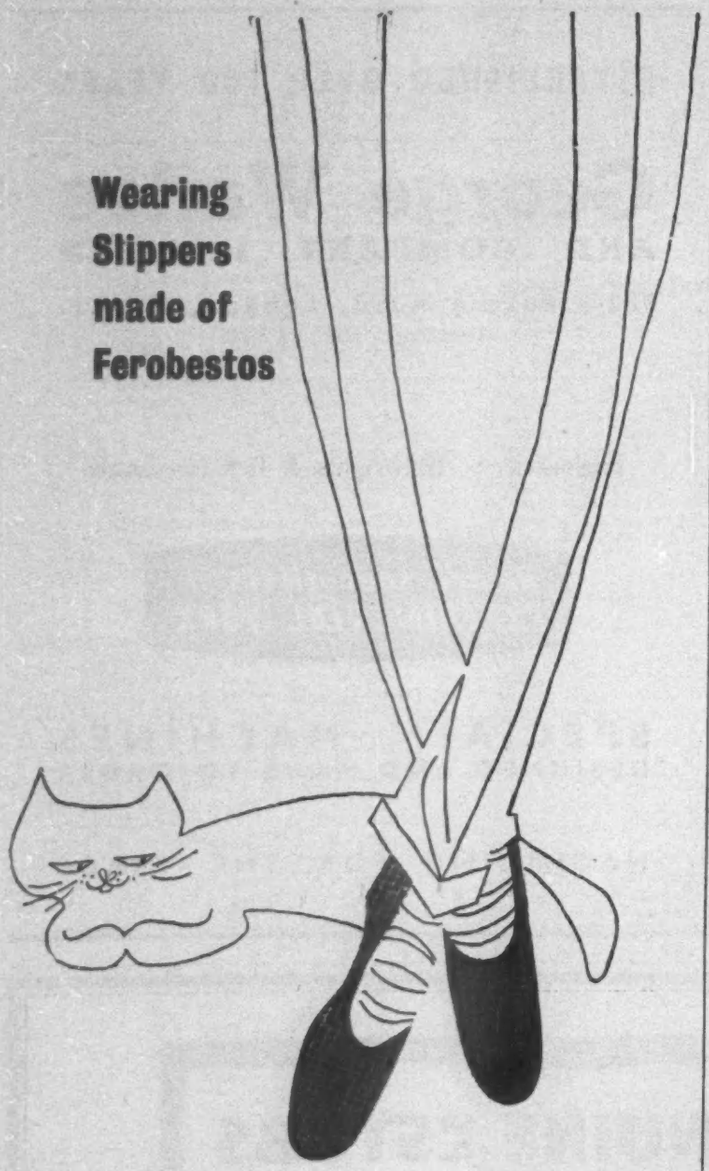
GENUINE PS STUBS FILES also have the same heritage of craftsmanship behind them as **GENUINE PS STUBS SILVER STEEL.**

Insist on these quality goods by specifying **GENUINE PS STUBS.**

PETER STUBS LIMITED
WARRINGTON · ENGLAND
FOUNDED IN 1773

SS26

Wearing Slippers made of Ferobestos



The versatility of Ferobestos springs from its many exceptional qualities

great physical strength
high strength-to-weight ratio
high temperature resistance
low moisture absorption
good chemical resistance
high wear resistance
good electrical resistance
high dimensional stability
low coefficient of friction

Ferobestos can be supplied from stock in sheets, rods, and tubes. Special mouldings can be made to order. We shall be glad to recommend and advise on the possibilities of Ferobestos as applied to any particular industry.

Wearing slippers is only one of the engineering applications of Ferobestos—the versatile, asbestos-reinforced plastic material. Here are just a few more of the ways Ferobestos can be used:—

Bushes
Coupling Discs
Bearings
Guides
Gears and Rollers
Piston Rings
Mounting Pads
Compressor Blades
Thrust Washers

A number of special grades of Ferobestos are made for particular applications including silicone impregnated for greater heat resistance, and graphite impregnated for more efficient lubrication. Ferobestos gear wheels ensure silence in operation.

J. W. ROBERTS LTD

FEROBESTOS DEPARTMENT

Chorley New Road, Lostock, BOLTON. Telephone: Horwich 840

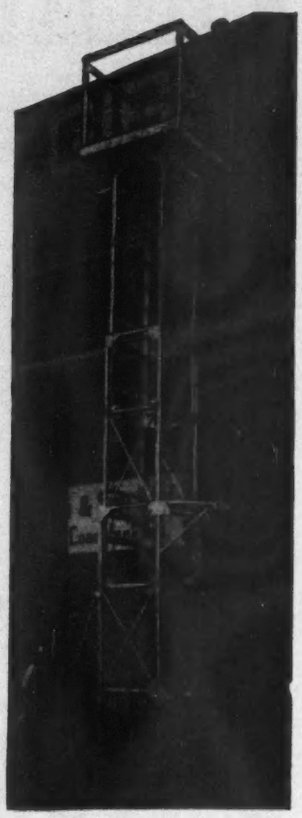
Branch Sales Offices: LONDON · GLASGOW · BIRMINGHAM · LEEDS

A Member of the Turner & Newall Organisation

MEET OVERHEAD JOBS ON A LEVEL FOOTING WITH . .

GIBSON TOWERS

Servicing of lighting, painting, window cleaning—bring all the 101 overhead jobs within the *safe* reach of your own maintenance staff—with a GIBSON tower. Saving the inconvenience and extra cost of outside contracts, a mobile GIBSON tower is rarely out of a job. Designed for factory use, tricycle-mounted Industrial models (with platform heights up to 33 ft.) are easily handled by one man. Other models include vehicle and trailer-mounted towers, and self-propelled types.



You can find out the full facts of GIBSON towers by writing for your copy of this leaflet.

Manufacturers :

JOHN GIBSON & SON LTD.

Jameson Place · Leith · Edinburgh 6

Distributors :

BERESFORD ATKINSON LTD., Hough House, Manchester 10.
MUNICIPAL SUPPLIES LTD., 2 Robert Street, Adelphi, London.

Smooth-running Efficiency . . .

METALRAX

Gravity
ROLLER CONVEYORS

The simple, inexpensive answer to the need for trouble-free conveying. *METALRAX GRAVITY ROLLER CONVEYORS* speed up the work and cut down on labour and costs.

A real investment in better methods you should certainly learn all about.

The current list, giving full details of sizes, straight sections, standard bends, adjustable stands and all prices will convince you. Please send for it.

JAMES OSCARD & CO.

DEPT. E, 139 WHITTON ROAD, TWICKENHAM. TEL. POPESGROVE 5281

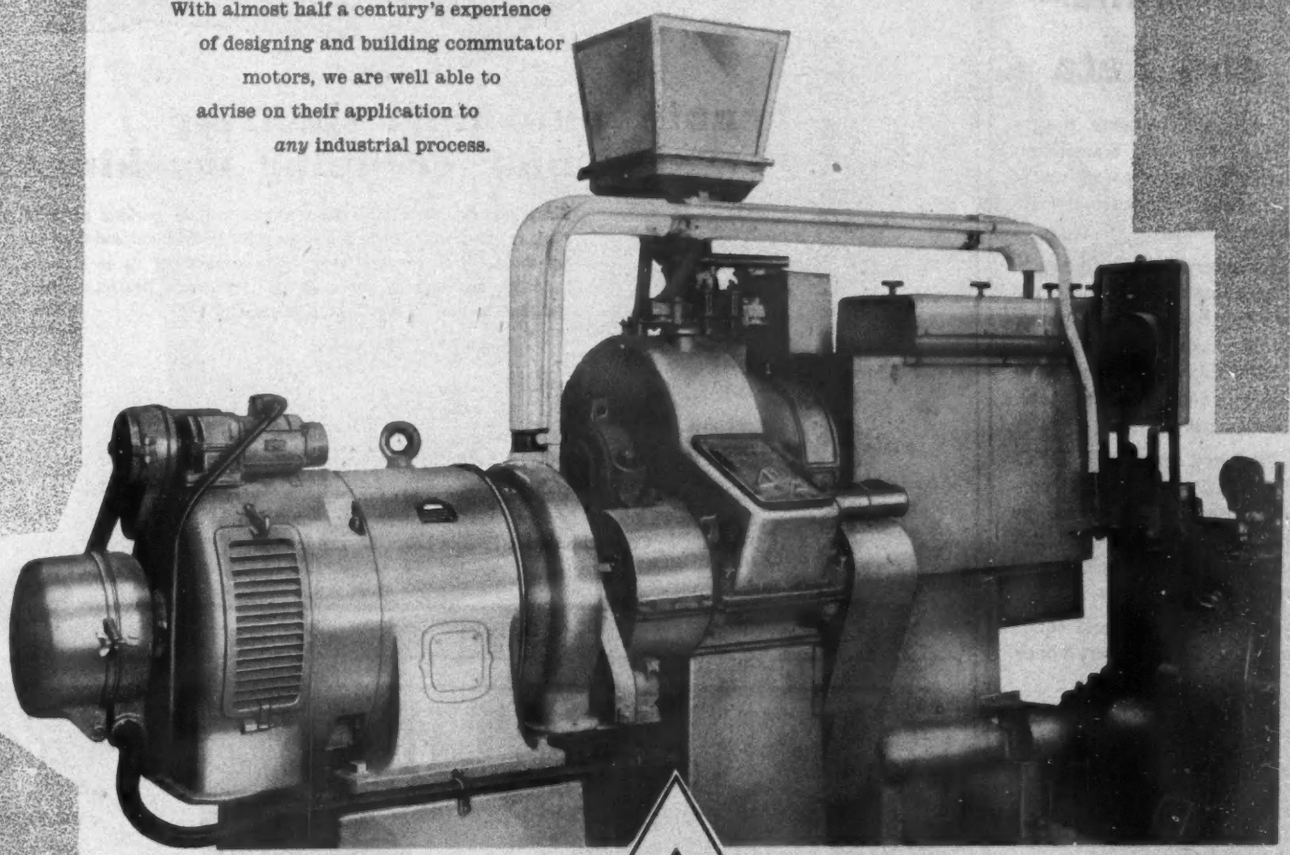
A. C. COMMUTATOR MOTORS . . .

for driving at EXACT speeds

In industries ranging from biscuit making to textiles, from steel fabrication to stocking manufacture, Fuller A.C. Commutator Motors are proving their worth.

With a commutator motor drive, a machine can be run at *exactly* its critical maximum speed, giving optimum output. Apart from increased productivity, a commutator motor also brings savings in power costs, paying for itself years before the end of its working life.

With almost half a century's experience of designing and building commutator motors, we are well able to advise on their application to *any* industrial process.



consult FULLER ELECTRIC

DIAMOND 18 8-1958 JUBILEE

FULLER ELECTRIC LTD · FULBOURNE RD · LONDON E.17

Telephone : LARkswood 2350
Also at Birmingham, Glasgow and Manchester
A member of the Hawker Siddeley Group

Electronic Engineering

Sputniks I, II and III—Calder Hall—Bristol Britannia—and Zeta

All these achievements, fraught as they are with tremendous possibilities for mankind, would never have been possible without electronics.

To understand fully the techniques employed on these and other projects the engineer should take "ELECTRONIC ENGINEERING"—the electronics industry's leading technical journal.

Published monthly "ELECTRONIC ENGINEERING" contains contributed articles by the best brains in the industry on the application of electronics to industrial problems.

New instruments and equipment are reviewed every month.

Twelve monthly issues cost 36/-

Single copies 3/- each

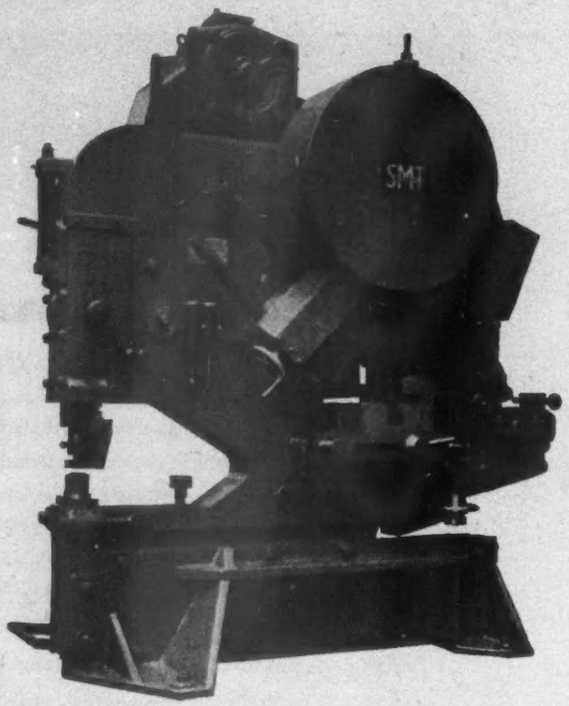
Order through Newsagent or direct from:-

Electronic Engineering
28 Essex Street, Strand, London, W.C.2.

Published by MORGAN BROTHERS (Publishers) LTD. Proprietors of "The Engineer"

Electronic Engineering

SCOTTISH machine tool corporation limited



bennie punching, shearing and cropping machines

These machines have steel plate frames and all working parts of steel. Endless uses will be found for them in structural and fabricating shops. This design is made in three sizes, for up to ¾" plate, but larger machines are also available. We have a Booklet available and shall be glad to send a copy on request.

17, Lynedoch Crescent, Glasgow, C.3. *DOUGLAS* 6586/9
58, Victoria Street, London, S.W.1. *VICTORIA* 2106
2, Sir Harry's Road, Edgbaston, Birmingham, 5. *CALTHORPE* 2541
The Building Centre, Brunswick Terrace, Leeds, 2. *LEEDS* 25250

SMT

IRON CASTINGS

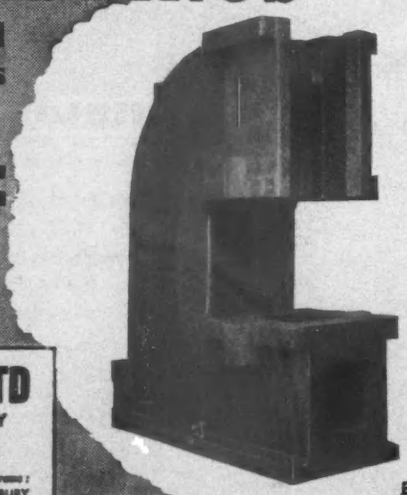
For Engineering and all Kindred Trades

ANY SIZE ANY SHAPE

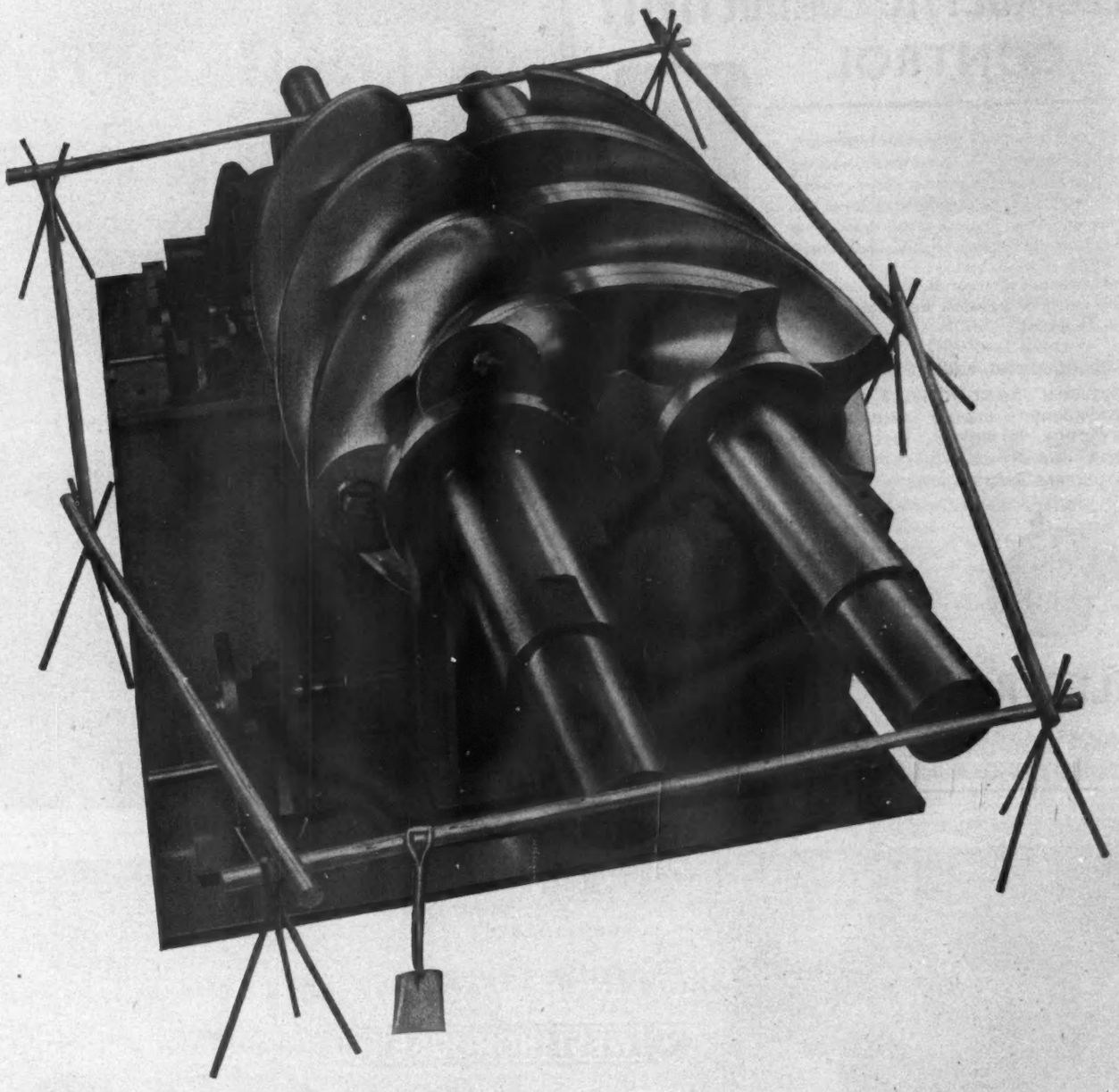
ALSO PATTERNS AND MACHINING

HB

HUNT BROS (OLDBURY) LTD
GRIFFIN FOUNDRY, OLDBURY
Near BIRMINGHAM
Telephone: BROADWELL 1181 & 1182 Telegrams: GRIFFIN, OLDBURY

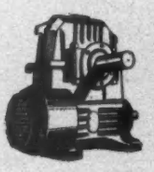


ESTABLISHED MORE THAN 100 YEARS



RIGHT UP OUR STREET!

You don't find these air compressor rotors being turned out every day. We've not been making them long ourselves. But we've been thinking about them for ages. In working out a manufacturing technique, our long experience in the production of accurate worm gears was an invaluable asset. We have now developed an entirely new machine for the exclusive production of rotors and high lead angle pump screws. If you've got a job of this sort . . . you're right up our street!



Holroyd *rotors*

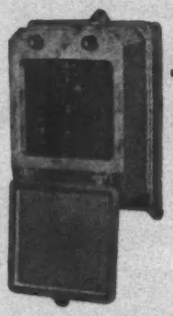
90 YEARS OF GEARS

With acknowledgement to James Howden Ltd., for whom we made the above rotors.

JOHN HOLROYD & COMPANY LTD., MILNROW, LANCS. TELEPHONE: MILNROW 3622

CRC.184

ELECTROLYTIC CONDUCTIVITY CONTROL



Type RC 4 conductivity controller.

The Type RC4 conductivity controller continuously monitors the purity of processed waters, wash and rinse waters, steam condensate, effluent concentration, etc., and operates electrical ancillaries such as magnetic valves, visual and audible signals, when the conductivity reaches a predetermined value.

A wide selection of indestructible measuring cells for a variety of conditions are available for use with the control.

Other equipment includes:

PORTABLE CONDUCTIVITY MEASURING BRIDGES AND RECORDERS · LIQUID AND SOLIDS LEVEL CONTROLS PROCESS TIMERS · PHOTOELECTRIC CONTROLS REGISTRATION CONTROLS FOR PACKAGING · ELECTRONIC COUNTERS AND BATCHERS, ETC.

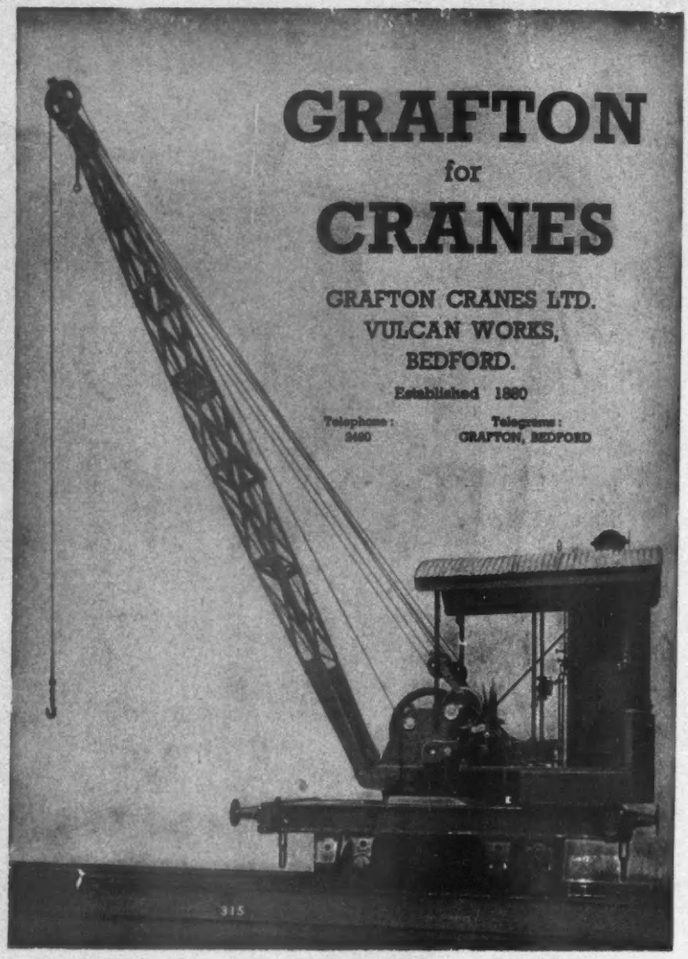
Series CCA (patented) pipeline measuring cell.

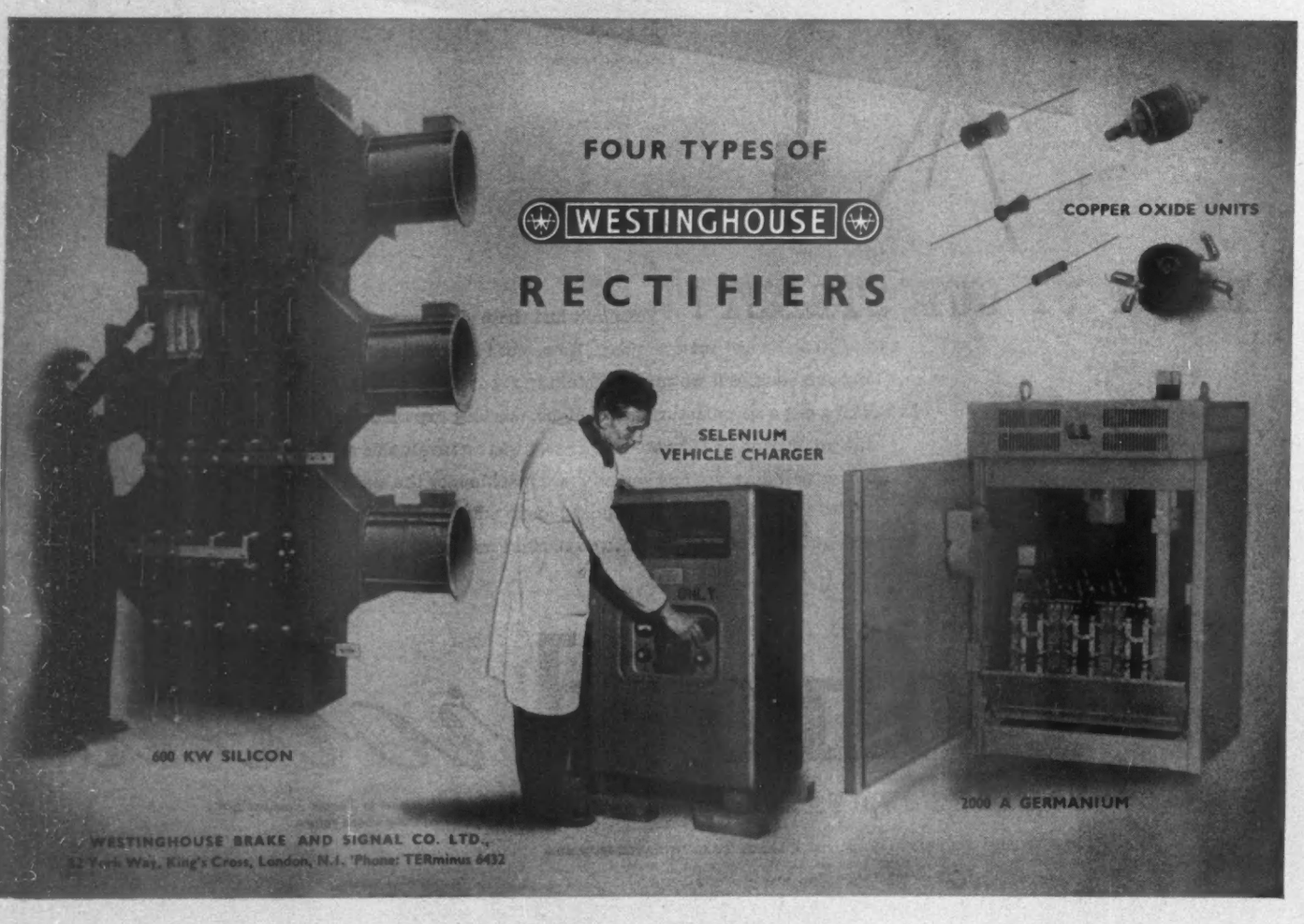
Descriptive leaflets RC4 and CC upon request.

ELECTRONIC SWITCHGEAR (LONDON) LTD.

WORKS ROAD · LETCHWORTH · HERTS *Telephone: Letchworth 1853*

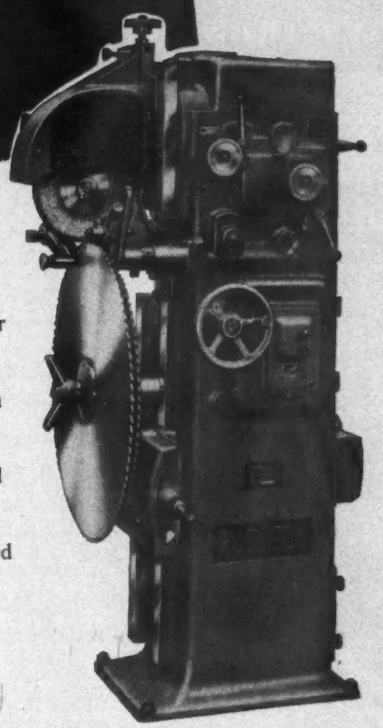
London Office : 47 Victoria Street, Westminster, S.W.1. Telephone: ABBey 2771/5





RUSSELL

11/40 AUTOMATIC SAW SHARPENING MACHINE



- Tooth form (variable) automatically generated
- Height difference of leader and follower teeth is automatic
- Automatic Pitch Doubler for tooth bevelling
- Rigid construction ensures accurate and rapid sharpening
- Operating mechanism totally enclosed and running in oil
- Built-in motor-driven dust exhauster
- Simple to operate

Damaged or broken teeth are caused by neglect. Economical saw blade life can only be obtained by keeping blades in good condition. This means frequent and regularly planned grinding. A machine specially designed to sharpen the tooth form of the modern circular cold saw blade provides the only efficient method of carrying out this operation.

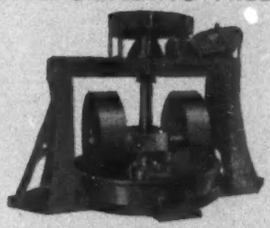
S. RUSSELL & SONS LIMITED, LEICESTER, ENGLAND

Backed by over forty years' specialised experience.

SR.551

TRADE Smedley MARK

PAN GRINDING MILLS



REVOLVING OR STATIONARY PANS
PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN

Smedley Brothers. Ltd.
Belper. Derbyshire.
Telephone: Belper 12

The service to complement your drawing office.

27 CLARENCE SQUARE,
BRIGHTON

PRIEST
FURNACES
FOR
ECONOMY
OF FUEL

PRIEST FURNACES LTD.
LONGLANDS · MIDDLESBROUGH F97

GUTMANN

SHOT BLASTING EQUIPMENT

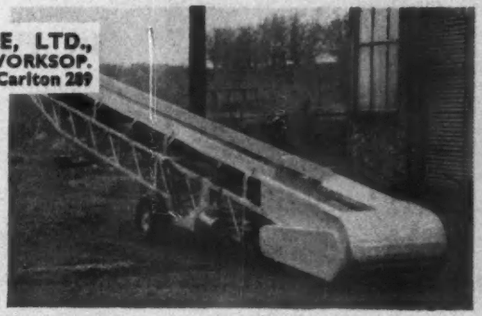
Continuous and Automatic

UNITED KINGDOM DISTRIBUTORS:

Suffolk Iron Foundry (1920) Ltd.

Stowmarket, Suffolk

J. W. TEALE, LTD.,
OLDCOTES, WORKSOP.
Phone: North Carlton 289



THE
LEEDS & BRADFORD BOILER Co.
LIMITED
STANNINGLEY
★
AUTOCLAVES &
VULCANISERS
with Pat. "Quicklock" door
CHEMICAL PLANT,
CREOSOTING PLANT,
VACUUM DRYING &
IMPREGNATING PLANT,
HYDRAULIC
PRESSWORK

HEAVY TRANSPORT

MARINE DIESELS

AIRCRAFT

MINING MACHINERY

EARTH MOVING

MACHINE TOOLS

Think of the clutch

In . . . . . out! In . . . . . out!

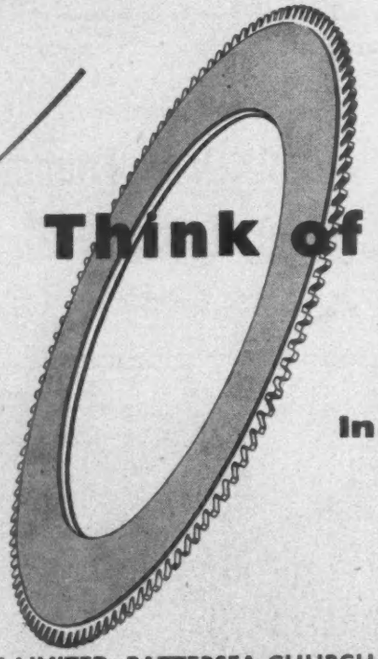
You can almost hear the Boat Race Commentator's voice intoning the repetitive action that wears out the crews in some twenty minutes.

And so with clutch plates. The punishing friction inseparable from repeated engagements of the clutch inexorably wears out the normal type of clutch plate, with regrettable speed. Result—costly idle time for refacing or replacement.

But this is not so with SINTERLINK clutch plates. Faced with sintered metal of cellular structure, they stand up to a tremendous amount of friction for very much longer than conventional clutch plates. The exceptional resistance to wear of SINTERLINK and its remarkable ability to withstand and dissipate heat are the explanation.

Any Answers?

We will gladly answer any questions either by correspondence or by personal call.



Think of MORGAN SINTERLINK

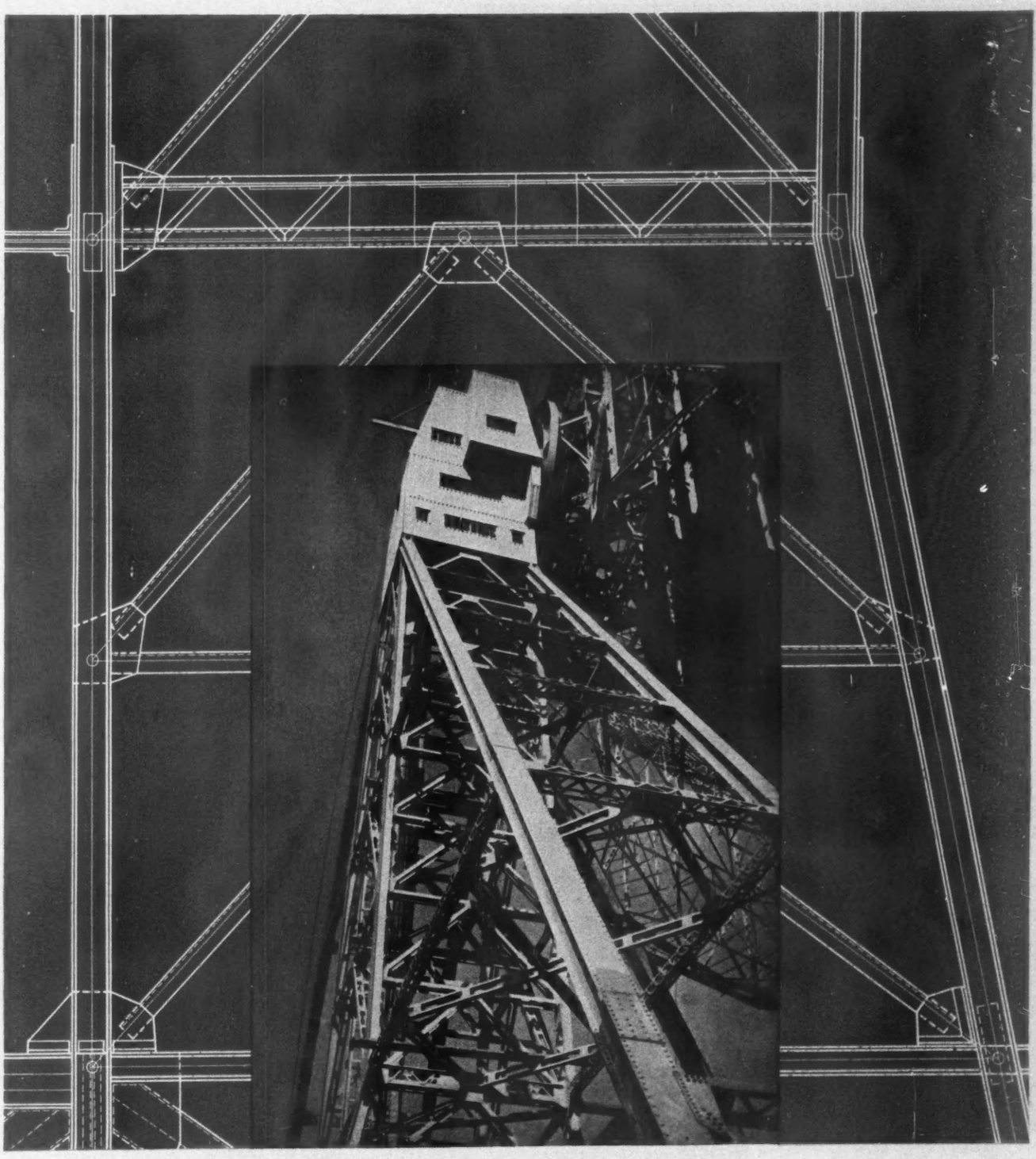
the final factor in Power Transmission

MAXIMUM MARKS TO SINTERLINK FOR

*Low Rate of Wear * Smooth Operation*
*Stability * Absence of Fade*
High Thermal Conductivity

THE MORGAN CRUCIBLE COMPANY LIMITED, BATTERSEA CHURCH ROAD, LONDON, S.W.11 Tel: BATTERSEA 8822

MI26/A



Radio telescope at Jodrell Bank built by United Steel Structural Company

Bowl diameter—250 *ft.*
Height of towers—180 *ft.*
Weight of structural steelwork—1,800 *tons*

Consulting engineers: Husband & Company

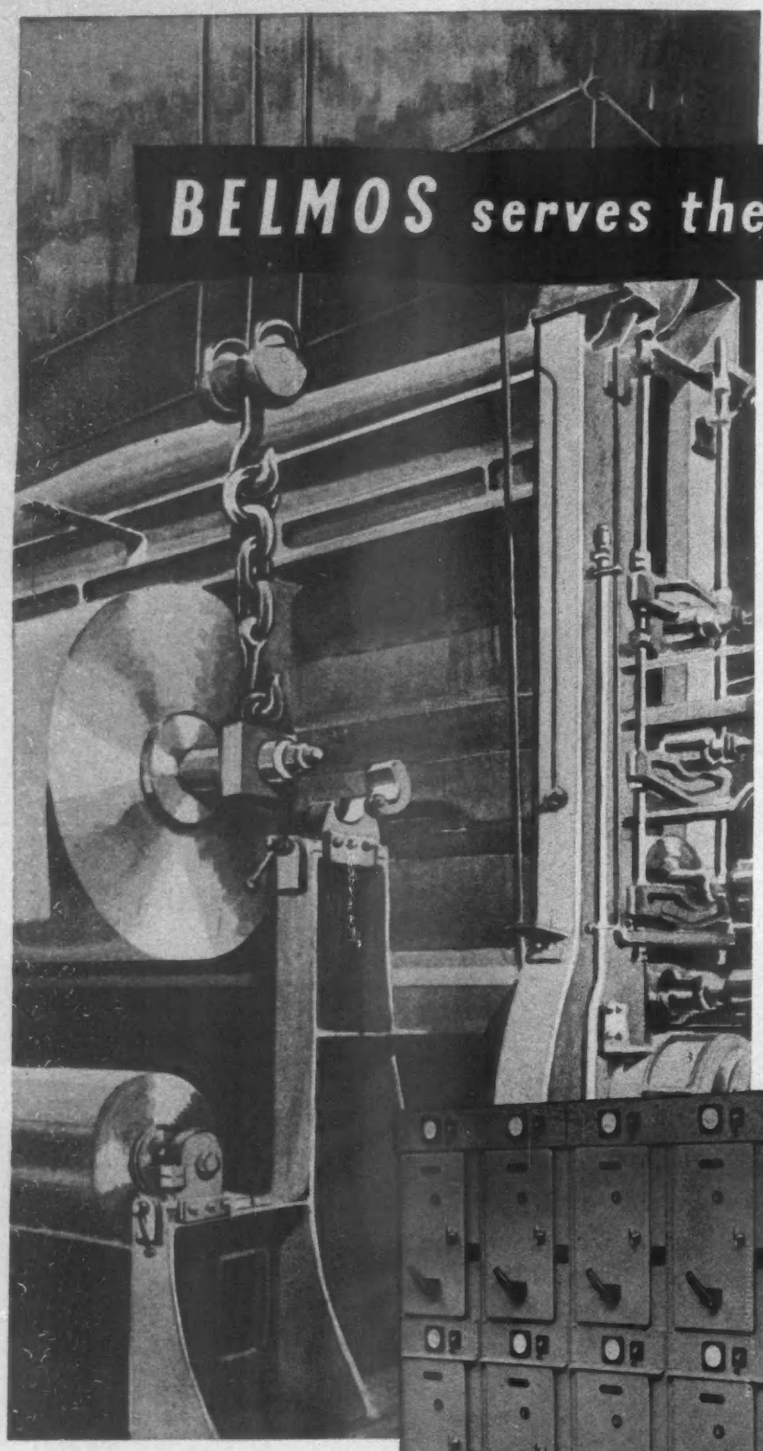
UNITED STEEL STRUCTURAL COMPANY LTD

SCUNTHORPE · LINCOLNSHIRE

UNITED STEEL STRUCTURAL CO. LTD. · THE UNITED STEEL COMPANIES LTD

U3835

K



BELMOS serves the Paper Industry

There is little need to emphasise the part played by motor control gear in the making of paper. Belmos control gear has earned the complete confidence of plant engineer and management alike in the paper making industry throughout the world.

With over thirty years' specialist experience in the manufacture of switchgear and motor control gear the company is justifiably proud of the part it is playing in the production of fine papers and boards.

An experienced engineering staff is available at the works and throughout the country, able to advise on the problems associated with the utilisation and application of switchgear and motor control gear.

Double tier Belmos switchboard for controlling motors up to 80–90 h.p., with terminal cubicles in centre of board for the termination of multi-core cables from remote control desk, as supplied to a large paper mill.

the Belmos company limited

BELLSHILL · LANARKSHIRE

LONDON · GLASGOW · BIRMINGHAM · NEWCASTLE · MANCHESTER · SHEFFIELD · CARDIFF

you too can be in clover with a SPEEDICUT "CHIPBREAKER" DRILL

Drilling mild steel components with a SPEEDICUT "CHIPBREAKER" DRILL our customer drills 17,000 ½" diameter holes before regrinding. The finish of the holes is excellent and the long life between regrinds enables the maximum advantage to be taken of advanced automatic machine tools.

Take advantage of the latest techniques in tool making—SPECIFY SPEEDICUT.

F.T.T. FIRTH-BROWN TOOLS LTD.
SPEEDICUT WORKS, CARLISLE STREET EAST,
SHEFFIELD ENGLAND

A GEARLESS GEARBOX

with the following advantages

Stepless speed variation over a 9 to 1 output speed range (1/3 to 3 times the input speed).

Constant horse-power transmitted throughout the speed range.

Flange mounted motors (when required) giving output speeds from 320 to 2880 r.p.m., and from 480 to 4320 r.p.m.

Output speeds as low as 3 to 27 r.p.m. can be obtained with flange mounted Reduction Gears. Special units are available for even lower output speeds.

Exceptionally light, sensitive and accurate control of speed setting.

Co-axial input and output shafts which rotate in the same direction.

Service reliability resulting from a simple design manufactured to high precision limits.

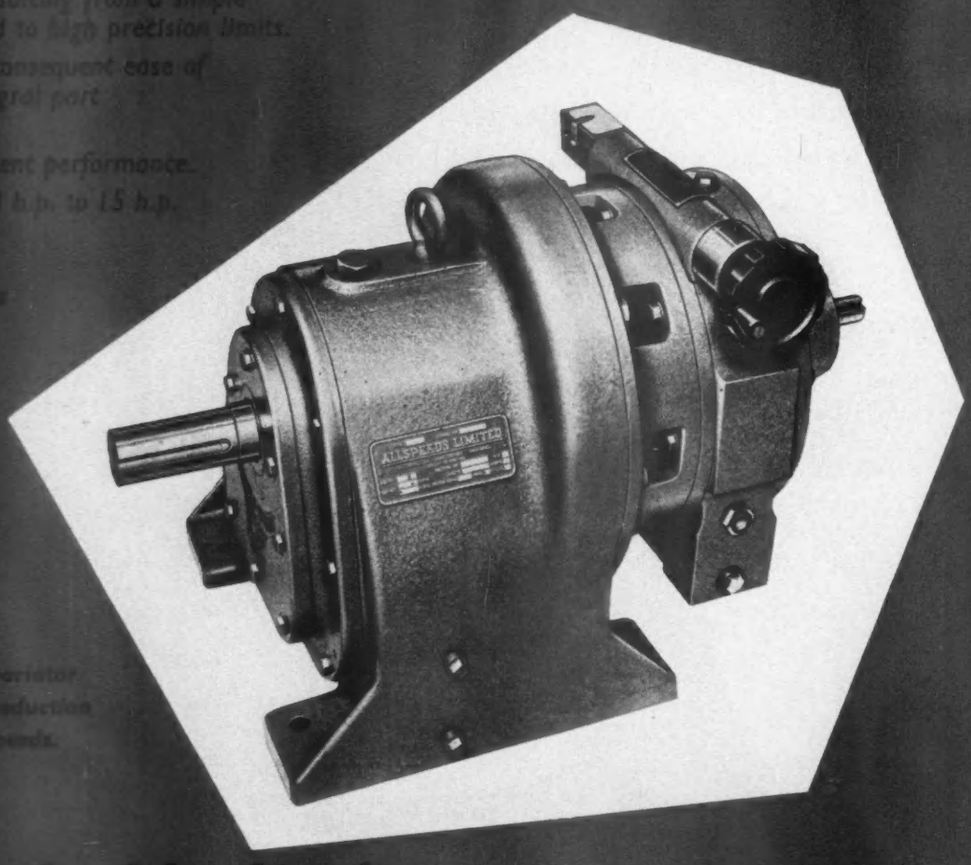
Compactness, with consequent ease of mounting as an integral part of a machine.

Vibrationless and silent performance.

Standard range 1/33 h.p. to 15 h.p.

PLEASE ASK FOR OUR CATALOGUE WHICH IS FREE AT YOUR REQUEST

Kopp VARIABLE SPEED GEAR



Illustrated is a 2 h.p. variator with flange mounted reduction gear for low output speeds.

Allspeeds Limited

Scholes Works, Clayton-le-Moors, Accrington, Lancs. Telephone: Accrington 5441 (4 lines)

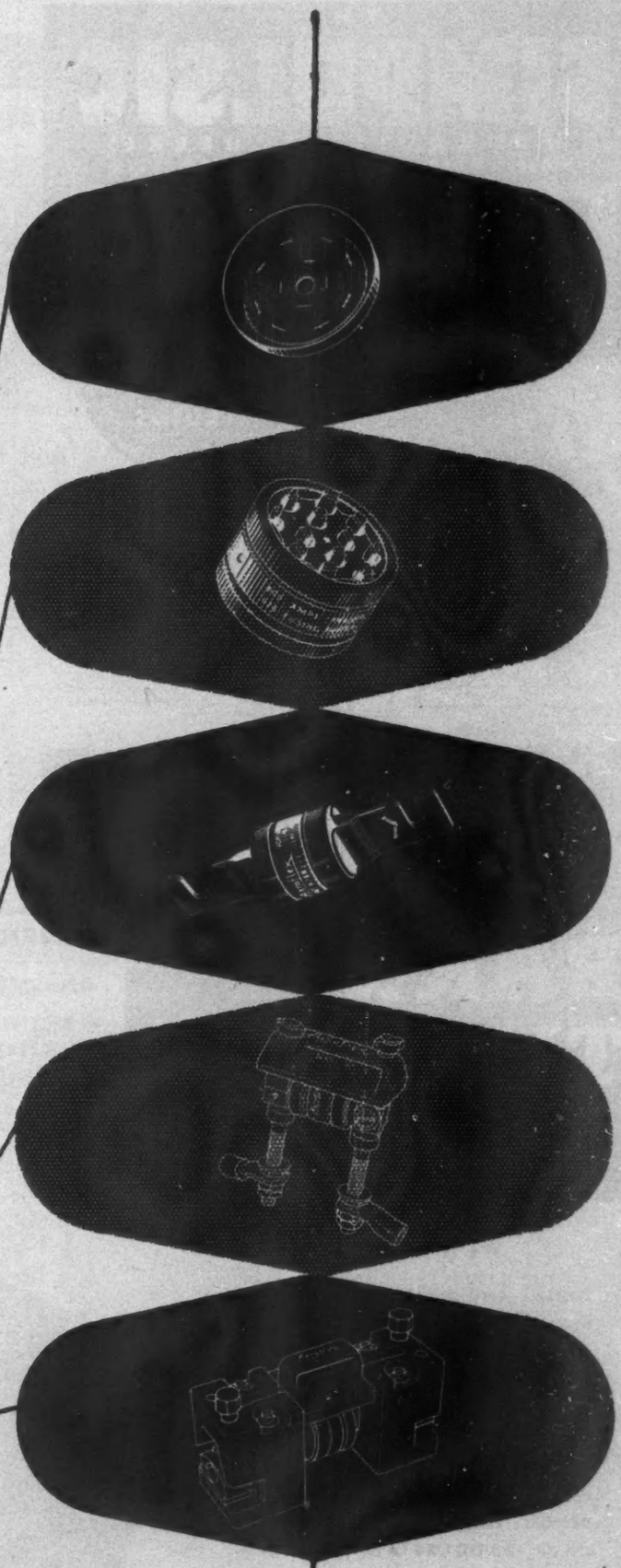
LONDON: 59 Park Road North, Acton, W.3. Tel: Acorn 7150
SCOTLAND: P.O. Box No. 1, Clarkston, Glasgow. Tel: Busby 2738
MIDLANDS: Much Park Street, Coventry. Tel: Coventry 63091
YORKSHIRE: 46 Park Square, Leeds, 1. Tel: 3-1146, 3-0285

Aeroflex Ceram HOPE'S PATENTS

FUSES and CONTACTS

These rewireable, multiple element cartridge fuse links afford a fusing factor of 1.25 and a breaking capacity of 25 M.V.A. They are interchangeable with other makes and they are embodied in the two types of Aeroflex Fuse units shown - the Link Type and the Radok Type. The latter has fully shrouded contacts in compliance with the Factory Acts.

The Aeroflex Ceram range is fully described in our publications Nos. CF1., RU1., LU1., and TC1.



Aeroflex HOPE'S PATENTS

PARMITER HOPE & SUGDEN LIMITED, MANCHESTER, 12

LONDON: 34 VICTORIA STREET, S.W.1. GLASGOW: 5 SOMERSET PLACE, C.3.

BIRMINGHAM: 39/41 CARRS LANE, 4.

dm PH 98

THE

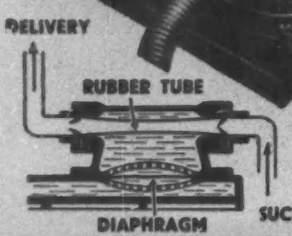
SIMPULSIC

'HYDRAULIC SQUEEZE' VARIABLE CAPACITY PUMP FOR

DIFFICULT LIQUIDS

ACIDS
ALKALIES
SLURRIES
AND VISCOUS
FLUIDS

CAPACITY: ZERO TO 11 G.P.M.

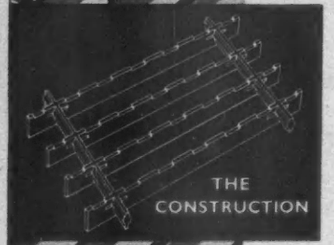


The Simpulsic Pump incorporates a flexible tube of chemical-resisting rubber through which the liquid to be pumped is forced by alternate pressure and suction impulses. At each end of the flexible tube there is a simple non-return valve of chemical-resisting rubber, and the end connections are of ebonite, designed to receive flexible rubber pipes. The pumped liquid never comes into contact with any metal parts and is handled throughout by chemical-resisting rubber.

AMES CROSTA MILLS & CO. LTD.
HEYWOOD · LANCASHIRE.

LONDON OFFICE: ABBEY HOUSE, VICTORIA STREET, LONDON, S.W.1 CVV 4030

OVALOCK FLOORING REGD.



Where strength and the passage of maximum light and ventilation is required . . .

. . . OVALOCK is the ideal flooring

The design of "OVALOCK" ensures that loads, either concentrated or distributed, can be carried with an ample factor of safety, and what is more, *it can be cut and worked around obstacles without losing any of these advantages.*

A positive non-slip surface is assured by the traverse members being just proud of the longitudinal members and the right angle construction thus formed makes dirt collection impossible. *Over 100,000 square feet of "OVALOCK" flooring has already been installed at the Portishead Generating Station.*

The fully qualified drawing office staff at Gardiner of Bristol will be pleased to answer any questions on design and installation—prompt attention is assured and full details will be sent on request.

GARDINER

Gardiner, Sons & Co. Ltd., Midland Works, Willway Street, St. Philip's, Bristol 2, and 8 William IV Street, Strand, London W.C.2

H-W.118

BARR THOMSON & Co., Ltd.

GENERAL ENGINEERS, FORGERS & PRESSERS

REGISTERED OFFICE & WORKS:—
NETHERTON IRON WORKS
KILMARNOCK, SCOTLAND

Grams and Cablegrams:
"BARR KILMARNOCK"
Telephone: KILMARNOCK 791

LONDON OFFICE—
10, NORFOLK ST.,
LONDON, W.C.2

Telegrams:
TUBENPIPE, PHONE, LONDON
Telephone:
COVENT GARDEN 0315/6/7

We Manufacture

DISHED AND FLANGED DRUM ENDS.
FLAT AND FLANGED TANK ENDS.
FLANGED COMPENSATING PLATES.
FLAT COMPENSATING RINGS.
EMBOSSED MANHOLE DOORS.
SINGLE FLANGED NOZZLES.
DOUBLE FLANGED STANDPIPES.
PIPE LINE FITTINGS INCLUDING BENDS, TEES, CROSSES, REDUCERS, CAPS, SADDLES AND SLEEVES.
PIPE LINE FLANGES, SLIP-ON WELDING NECK AND BLANK.
MISCELLANEOUS PRESSINGS AND FORGINGS.

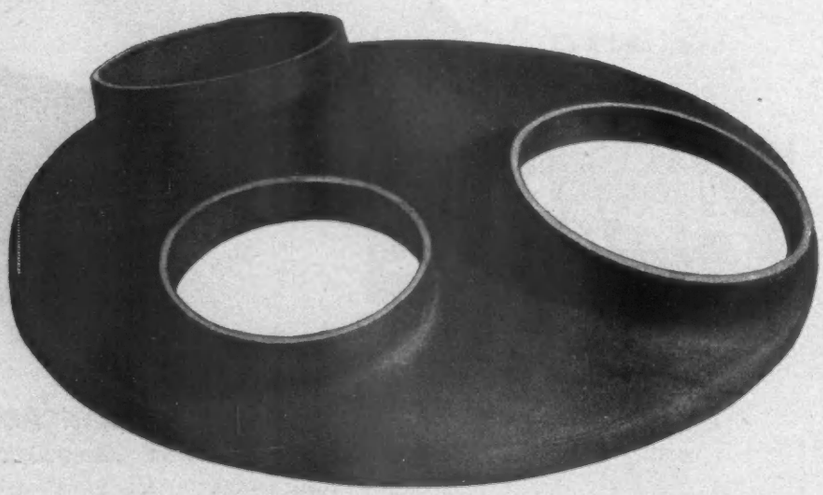
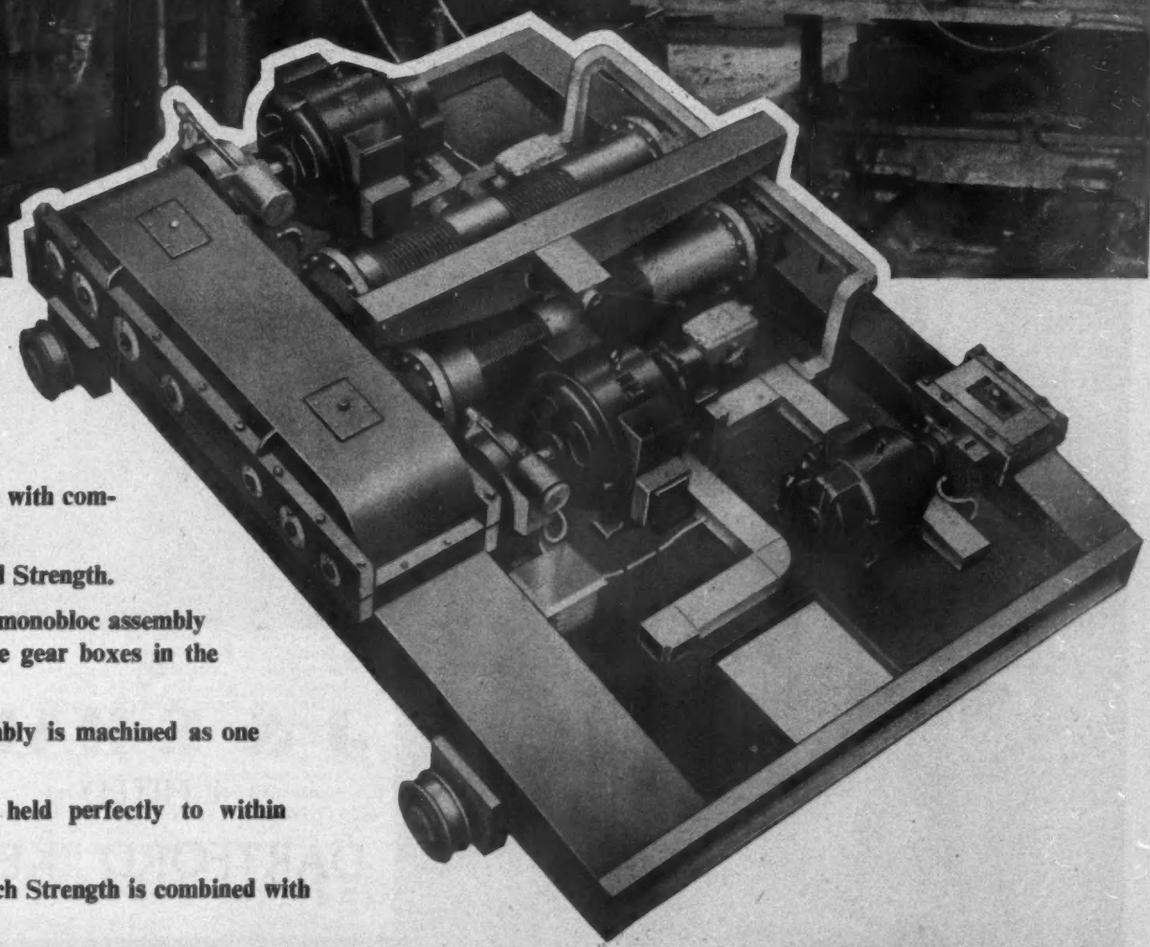


Illustration of 60in. dia. ½in. thick Dished and Flanged End with Plugged Outlets.

Constructional Features of Carruthers Cranes

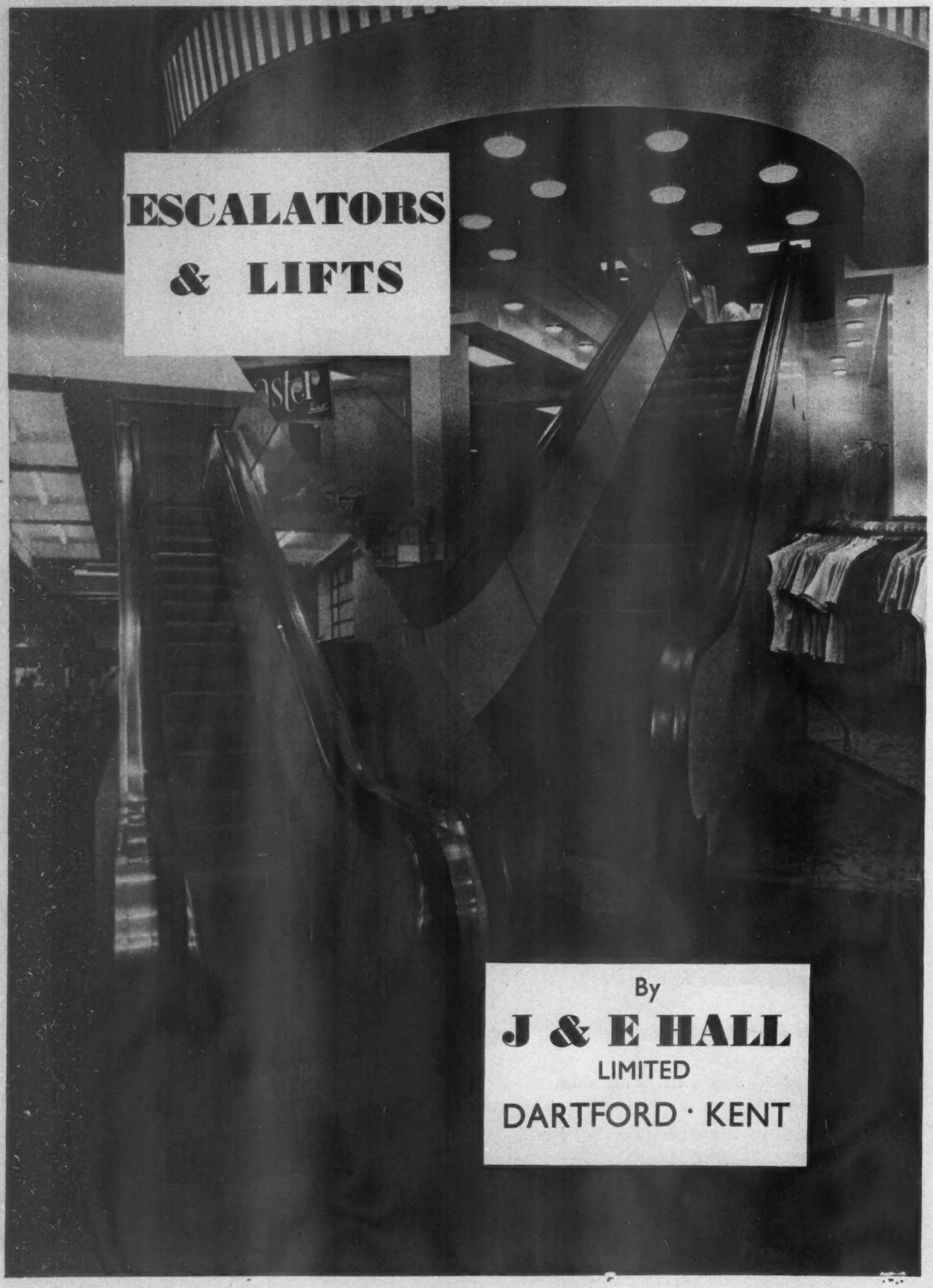


Special Features . . .

- ★ Efficient Service with compactness.
- ★ Accessibility and Strength.
- ★ Fabricated as a monobloc assembly incorporating the gear boxes in the framing.
- ★ Complete Assembly is machined as one entity.
- ★ Alignments are held perfectly to within Machine limits.
- ★ Structure in which Strength is combined with lightness.

J. H. CARRUTHERS & CO. LTD., 27, HAMILTON ST., GLASGOW, S.2
London Office: Abford House, Wilton Rd., Victoria, S.W.1

carruthers


ESCALATORS
& LIFTS
By
J & E HALL
LIMITED
DARTFORD · KENT

CAROBRONZE

COLD DRAWN PHOSPHOR BRONZE

means

MINIMUM WASTAGE
HIGHEST QUALITY
and ECONOMY

TUBES require very little machining to produce the finished component. Drawn tubes mean a saving in raw material and machining charges. A wide range of standard sizes with small machining allowances is specially helpful to the small user.

RODS have only a small margin on diameter. Economical production is possible of thick-walled or flanged bushes, valve guides, gear wheels and other small bore components.

The cheapest metal for high quality Bearing Bushes: High Load Capacity = Shorter Bushes Excellent Physical Properties = Thinner Bushes • Small Machining Allowances = Minimum Wastage & Labour

CAROBRONZE LIMITED SCHOOL ROAD, BELMONT ROAD, LONDON, W.4.
Telegrams: CAROBRONCE, CHISK, LONDON · Telephone: CHISWICK 0245

Regd. Trade Mark CAROBRONZE

ESTABLISHED OVER 50 YEARS

TELEPHONE EAST 1403

WOOD REFUSE AND DUST EXTRACTION ENGINEERS

"Let us investigate your dust problem at our expense"

WALLIS & C° (MILLWALL) LTD

GENERAL & INDUSTRIAL SHEET METAL WORKERS
SHIPS' VENTILATOR MAKERS
ALPHA WORKS, MILLWALL
LONDON . . . . . E. 14

SATISFACTION ASSURED

WITH

Jizer
SOLUBLE SOLVENT

DE-GREASANT

Non Acid. Non Corrosive. Jizer applied by brush or spray removes Grease, Grime and Oily deposits from floors, walls and windows easily and is ideal for the removal of cutting oils, or oil smears from all metals prior to processing. Last but by no means least use JIZER for machinery cleaning. A clean machine leads to increased efficiency and pride in the job.

AND

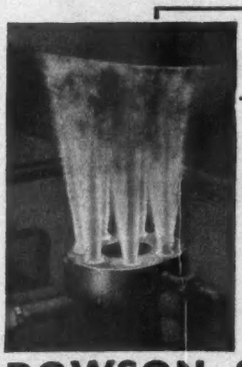
Swarfega
HAND CLEANSER

Swarfega Antiseptic Handcleanser removes all industrial soiling from the hands be it oil, paint, tar, rubber compounds or just ingrained grime. Leaves hands in a clean healthy condition. Work people think it ideal. Moreover it can be dispensed from completely wasteproof containers which offer Management economy, convenience and make for ease of distribution. Swarfega therefore is the answer for both interested parties.

POST COUPON FOR SAMPLES

Please send me details and samples of Jizer / Swarfega
NAME .....
ADDRESS .....
..... ER

DEB CHEMICAL PROPRIETARIES LTD., BELPER DERBYSHIRE



HIGH EFFICIENCY 'TARGET'
—Gas Burners for all purposes

Many new gas burner applications are possible by the introduction of "Target" gas burners. In this system, air and gas are intimately mixed producing pencil flames of high intensity which require no additional air for combustion. It is therefore suitable for use in the open or in closed combustion spaces. The velocity of the mixture issuing from the jets promotes turbulence and high rates of heat transfer. The burner consists of multiple jets which can be arranged to suit any flame pattern.

Write for Bulletin GB.1

DOWSON & MASON LIMITED
ALMA WORKS · LEVENSHULME · MANCHESTER
Telephone: HEATON MOOR 6251 (5 lines) Telegrams: Gasify, Manchester 19

"Vokes 'Top Servicing' lubricating oil filter makes life a lot easier!"

'Top Servicing' is yet another Vokes development. It cuts maintenance time to a minimum—saves man hours and money. You simply unscrew the clamp ring, remove the cover plate and inner seal, and withdraw the filter element. The clamp ring may be locked in any radial position, a particularly useful feature in confined spaces. 'Top Servicing' is typical of Vokes practical approach to filter problems. If you have a filtration problem please contact our engineers. They will be glad to help you.

VOKES *Pioneers of Scientific filtration*

VOKES LIMITED · GUILDFORD · SURREY

Telephone: Guildford 62861 (6 lines) · Telegrams and Cables: VOKESACESS, GUILDFORD, TELEX · Telex: 13-535 VOKESACESS GFD.

Vokes (Canada) Ltd., Toronto. Vokes Australia Pty. Ltd., Sydney. Represented Throughout the World

V277

soot blowing

is a push-BUTTON job

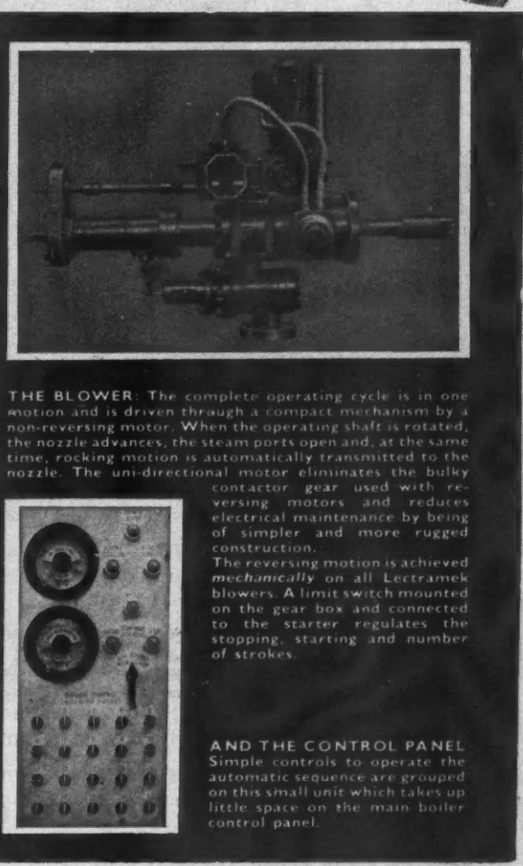
with the NEW CLYDE system

UNIFIED LECTRAMEK CONTROL SYSTEM

most efficient yet devised.

Considerable savings in initial cost and valuable boiler room space have been achieved by this new system of electrical control which works in conjunction with the Clyde Lectramek Soot Blower* - the original blower employing a uni-directional motor. Control is exercised from a small panel which indicates all essential information to the operator.

Further information is given in our publication No. CBL. 1954 which will be supplied on application.



THE BLOWER: The complete operating cycle is in one motion and is driven through a compact mechanism by a non-reversing motor. When the operating shaft is rotated, the nozzle advances, the steam ports open and, at the same time, rocking motion is automatically transmitted to the nozzle. The uni-directional motor eliminates the bulky contactor gear used with reversing motors and reduces electrical maintenance by being of simpler and more rugged construction.
The reversing motion is achieved *mechanically* on all Lectramek blowers. A limit switch mounted on the gear box and connected to the starter regulates the stopping, starting and number of strokes.

AND THE CONTROL PANEL
Simple controls to operate the automatic sequence are grouped on this small unit which takes up little space on the main boiler control panel.

CLYDE

*Over 5,000 blowers of this type in use all over the world

CLYDE BLOWERS LTD.
CLYDEBANK · SCOTLAND
Tel: Clydebank 2161/4

THE SKERNE WORKS LTD.

ALBERT HILL
DARLINGTON

COLD FORMED SECTIONS
From
HOT OR COLD STRIP

LIGHT PRESSINGS up to ⅜" thick

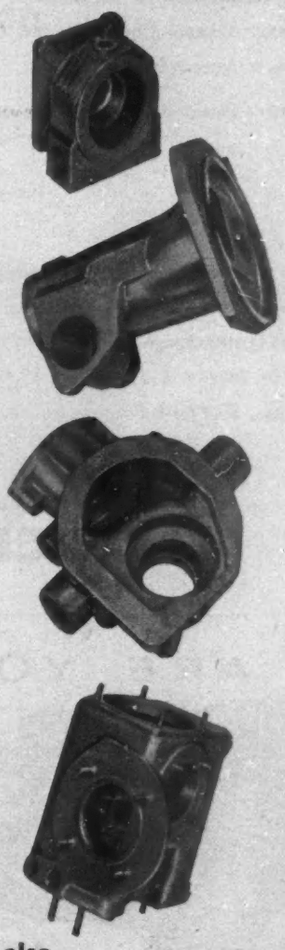
ANGLES, CHANNELS and many other sections in thicknesses up to 10 gauge

LIGHT STEEL FABRICATIONS riveted or welded

Larger thicknesses and sections can be undertaken on large capacity Brake Press

All enquiries promptly dealt with

GREY IRON
ALUMINIUM
NON-FERROUS
CASTINGS
AND
MACHINED ASSEMBLIES



also

DIE CASTINGS IN ALUMINIUM MAZAK, LEAD & TIN ALLOYS

ECLIPSE FOUNDRY & ENGINEERING CO. (DUDLEY) LTD.

BRITANNIA WORKS, SEDGLEY ROAD, WEST

TIPTON, STAFFS.

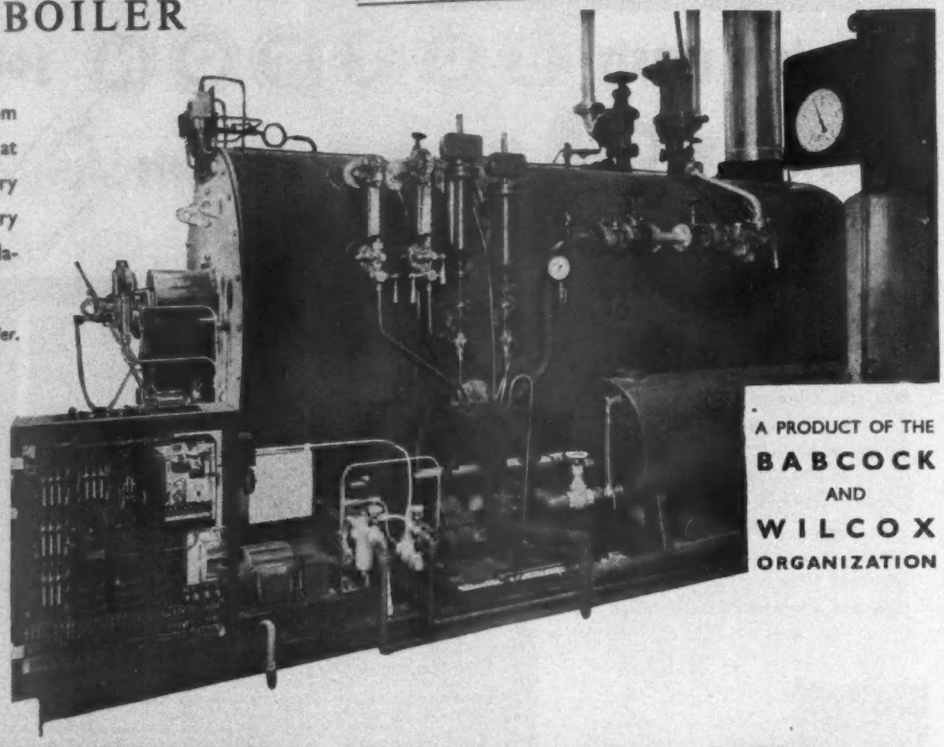
Telephone: TIPton 2545 (3 lines)

"THE STEAMBLOC"
PACKAGED BOILER

Fully Automatic—Oil Fired
High Efficiency Boiler Plant
GUARANTEED 82.5% EFFICIENCY

The Steambloc is designed in a range from 1,500 to 18,000 lb. steam per hour (from and at 212°F). Its special three-pass design enables very high efficiencies to be obtained under ordinary commercial operating conditions. On many installations it exceeds 85%.

Send for Publication No. 1628/3—The Steambloc Packaged Boiler.



A PRODUCT OF THE
BABCOCK
AND
WILCOX
ORGANIZATION

Lower steam requirements are met by the CLARKSON Packaged Vertical Boiler of Thimble Tube Design. Range 250 lb. up to 3000 lb. steam per hr. Max. W.P. 120—Clarkson Thimble Tube Boilers. Send for Publication No. 702.

SPENCER - BONECOURT - CLARKSON LTD.

28 Easton Street, London, W.C.1. Telephone: Terminus 7466

ARE YOU building a prototype?

Then see our design staff first. They will design your castings for maximum strength, and at the same time reduce complexity and cut costs. That way you'd get cheaper, more sound castings of guaranteed quality and accuracy. Our technical teamwork can tackle *all* your problems—and solve them.

CASTINGS FROM A FEW OUNCES TO 10 TONS... in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze, and light alloys. Specialists in high-tensile aluminium-bronze castings, centrifugal-cast wheel blanks, and chill-cast rods and tubes. Continuous cast phosphor-bronze bars up to 12 feet lengths.

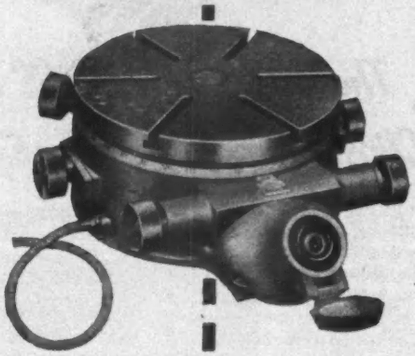
BIRSO TRADE MARK BN

NON-FERROUS CASTINGS
HIGH-DUTY IRON CASTINGS
PRECISION MACHINED BUSHES AND BEARINGS

T. M. BIRKETT, BILLINGTON & NEWTON LTD
HANLEY AND LONGPORT, STOKE-ON-TRENT, ENGLAND
Head Office: HANLEY, Phone: Stoke on Trent 22184 5 6 7. LONGPORT, Phone: Stoke on Trent 87303

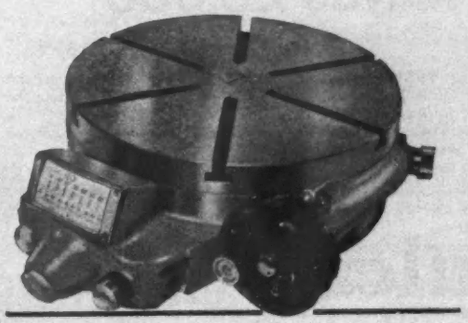
OMT

OPTICAL ROTARY TABLES introduce test house accuracy to production



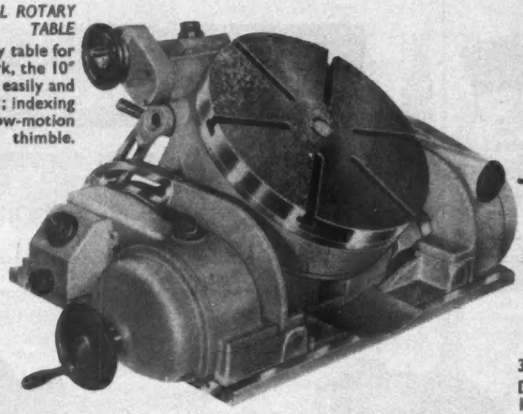
16" PROJECTION TYPE ROTARY TABLE

Modern in design and highly accurate, the 16" Projection Type Rotary Table incorporates an optical system whereby the angular position of the revolving table is projected on to a screen, and is read direct to 2 seconds of arc.



10" OPTICAL ROTARY TABLE

A sturdy table for smaller work, the 10" model is easily and rapidly set; indexing is by a slow-motion thimble.

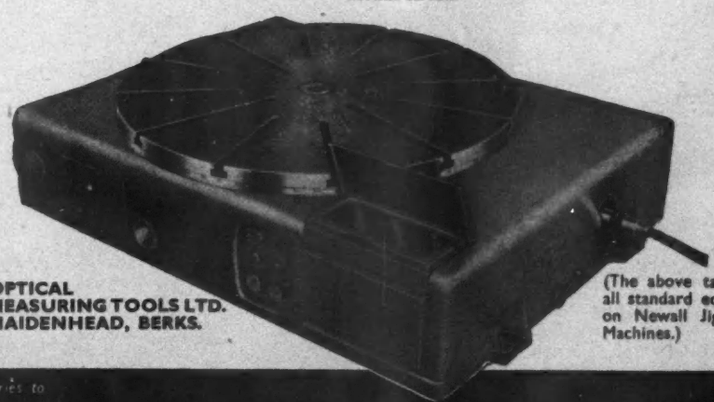


30" PROJECTION TYPE ROTARY TABLE

Designed for rotary indexing of large workpieces up to 1,200 lb. in weight and reading direct to 1 second of arc, the 30" Projection Type Rotary Table incorporates a power operated platen. A supplementary screen unit is embodied permitting readings to be taken when workpieces considerably in excess of the platen diameter obscure the normal screen.

16" ROTARY AND INCLINABLE TABLE

The 16" Rotary and Inclinable Table incorporates a rotary action through 360 degrees and an inclinable movement through 90 degrees. Readings for both rotary and inclinable movements are direct to 1 second of arc. Also made in 12" platen size.



precision products of

OPTICAL MEASURING TOOLS LTD. MAIDENHEAD, BERKS.

(The above tables are all standard equipment on Newall Jig Boring Machines.)

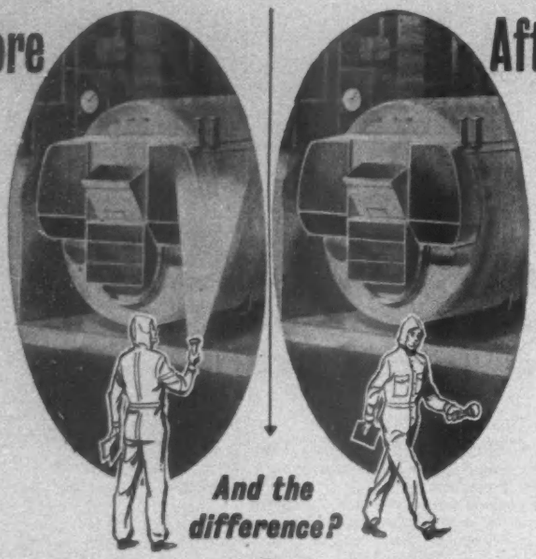
Please address enquiries to

NEWALL GROUP SALES LIMITED

PETERBOROUGH TELEPHONE PETERBOROUGH 1271

P1502

Before



After

And the difference?

Maybe £5,000

How? Faulty water gauges were spotted, and an accident costing £5,000 or more has been prevented.

Spotted by whom? By a Vulcan Engineer-Surveyor during his regular inspection of the boiler. Experience gives him almost second sight into the accidents that are waiting to happen.

Are his services expensive? Not at all. Your broker will tell you that, though the Vulcan man is a specialist, his services cost no more than insurance and inspection by general practitioners.

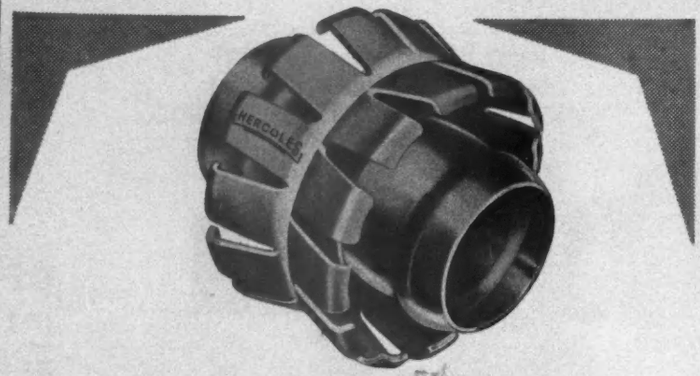
What Vulcan insures, Vulcan inspects—thoroughly and *regularly*. As a result our clients have made us one of the largest engineering insurance companies in Europe.

THE **Vulcan**

BOILER & GENERAL INSURANCE CO. LTD.
67 KING STREET, MANCHESTER 2

VULCAN INSPECTS—AND PROTECTS

FREE
"Vulcan"—a journal of absorbing interest to all users of plant and machinery, with reports of accidents and safety hints. For a year's subscription — free — write now to Dept. 18.



These HOSE FITTINGS need

NO Clips, Clamps, Wires or Special Tools

HERCULES give you the strongest and simplest-to-fix Hose Fittings ever devised. The secret is in the Claws, with their positive gripping action, which are fixed simply by hammering down. No extras, no special tools—only the moderate cost of the fittings themselves.

The Hercules range includes hose repairers, screw couplings, adaptors, etc., for pneumatic, oxy-acetylene and all industrial hoses.

WE ALSO MAKE STANDARD LUG-TYPE HOSE COUPLINGS IN BRASS OR GUN-METAL; HOSE CLIPS, etc.

HERCULES
SIMPLY HAMMER IT

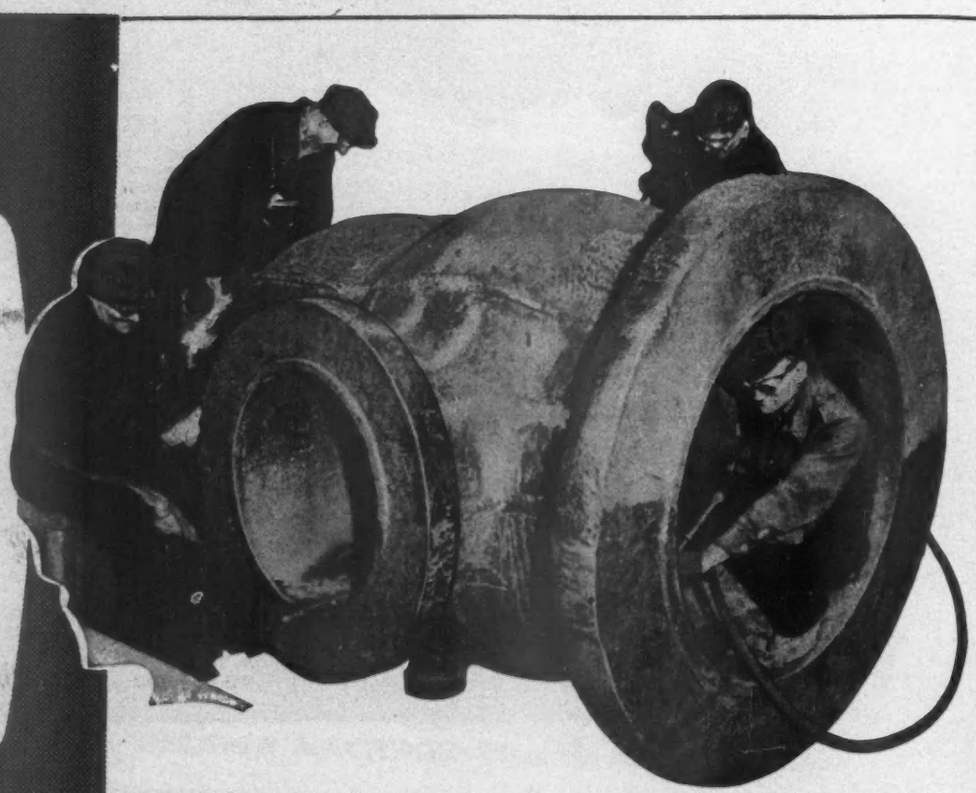
CUT HOSE COSTS

NEWTON SALES COMPANY LTD.,
(Industrial Division), 517, Fulham Road, London, S.W.6
Tel: FULham 4228

THE SPECIALISTS IN HOSE FITTINGS

Steel Castings

for Shipbuilding and General Engineering up to a finished weight of 40 tons.



THE STEEL COMPANY OF SCOTLAND LIMITED

HEAD OFFICE: 132 BLOCHAIRN ROAD, GLASGOW, N.1
LONDON OFFICE: 17 GROSVENOR STREET, W.1

MANVERS CENTRALIZATION SCHEME:

From the top of the newly constructed Coal preparation plant a small section of the immense network of railway sidings

The supply and installation of these sidings and the adjoining trackwork for the new Coal Carbonization and Benzole Rectification Schemes were entrusted to the Eagre Construction Co., Ltd., by the National Coal Board. Over 9,000 tons of Iron and Steel were used in the construction of the forty miles of track and 230 turnouts and Special Point and Crossing layouts comprising the combined railway Sidings.

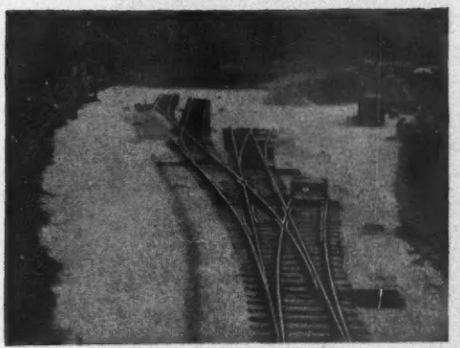
Eagre's skilful planning and practical experience in the day-to-day working of Colliery Sidings ensured that this vast scheme was laid efficiently to schedule, and without the slightest interruption of existing Colliery traffic.

Photograph by courtesy of National Coal Board

WORK BEGINS AT CADEBY:

The National Coal Board again entrusts the Eagre Construction Co. Ltd. with a similar project. Earthworks, Drainage, Track Laying and ancillary works for thirteen miles of Sidings are now in progress at Cadeby Main.

for a complete Track Service



Photograph by courtesy of National Coal Board

In aadition to its activities in the Nation's Coalfields, the Eagre Construction Co. Ltd. has worked continuously during the past ten years for British Railways, the Gas Board, the United Steel Companies, and has carried out large Power Station Projects for the Central Electricity Authority.

SURVEY
DESIGN
SUPPLY
INSTALLATION

Whatever the magnitude of your siding requirements, be sure to consult

EAGRE CONSTRUCTION CO. LTD.

East Common Lane SCUNTHORPE Lincs. Telephone: Scunthorpe 4513-7

RUBBER AND SYNTHETIC UNITS
(to any specification)

IN

NATURAL, NEOPRENE SYNTHETICS
GASKETS, OIL SEALS, SHOCK UNITS
WHEELS, RUBBERISED CORK, SPONGE
PLASTIC FOAM RUBBER

SAM KAY RUBBER CO. LTD.
HOPE MILL · PORTWOOD PLACE · STOCKPORT
TELEPHONE: STO 2617/8

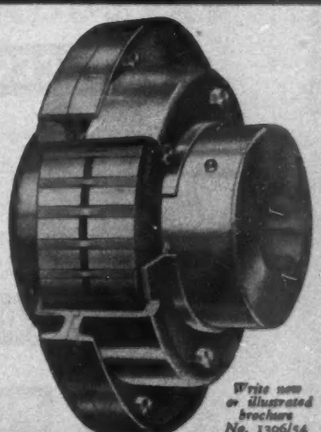
The Steel-Shaw Patent Flexible Coupling

THE SECRET IS IN THE DESIGN It is the shape of the springs—separate individual keys which give the high degree of efficiency.

Greater safety as stresses are equally divided. Perfect balance at all speeds. Rarely requires lubrication, as a lubricant is packed inside couplings.

Smaller total diameter to transmit a given torque than other couplings of similar type. Machined all over. Capacity from ·0125 to 24·80 B.H.P./R.P.M.

Diameter from 4½ to 38 ins.

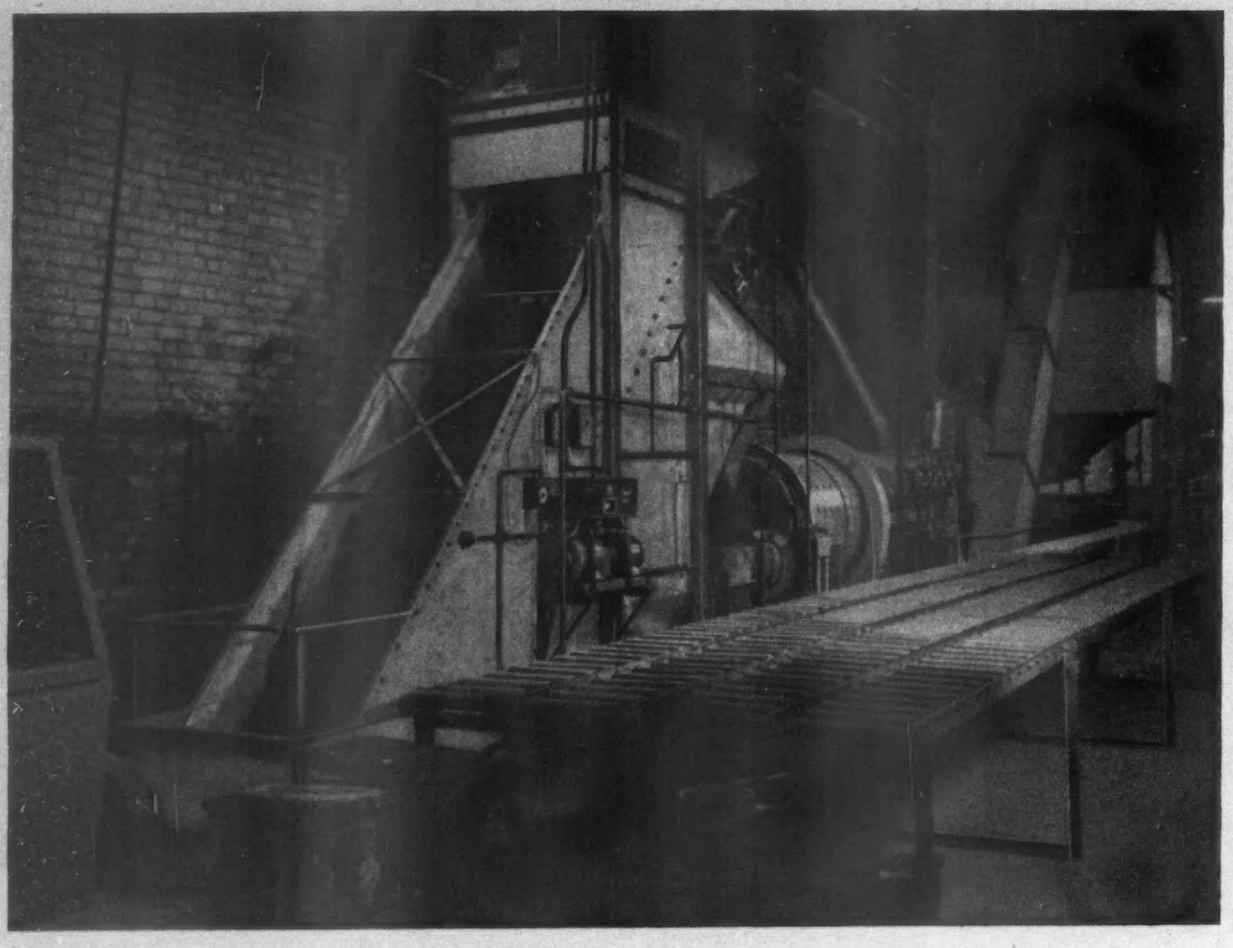


Write now for illustrated brochure No. 1306/54

There's a STEEL-SHAW *answer to YOUR problem*

STEELE & COWLISHAW LTD., Dept. 16, Cooper Street, Hanley, Stoke-on-Trent
Telephone: Stoke-on-Trent 28333 (5 lines) Telex 36-530.
London Office: Westwood House, Swallow Street, Piccadilly, London, W.1.
Tel: REGent 8301

10532/SCL



MANUFACTURERS OF

MECHANICAL HANDLING

PROCESSING

&

STORAGE

PLANTS

FOR ALL PURPOSES

The **LAWRENCE ENGINEERING COMPANY** have long been well known in a number of industries as manufacturers of complete Mechanical Handling Processing and Storage Plants for all purposes. The above photograph shows a typical installation, this being a plant for special process in the car industry.

Individual machines produced —

- SCREW CONVEYORS
- BELT CONVEYORS
- CHAIN CONVEYORS of all types
- CRANES & LIFTING APPLIANCES
- ELEVATORS
- SKIP HOISTS
- SCREENS

also special-purpose machines for —

- ROLLING MILLS
- STEEL WORKS
- QUARRIES
- OIL MILLS
- CEMENT WORKS
- CAR MANUFACTURERS

THE LAWRENCE ENGINEERING CO. LTD.

CITY ROAD · TIVIDALE · TIPTON · STAFFS

TELEPHONE : BROadwell 1382

TELEGRAMS : Lawrence, Birmingham.

at Ford's of Dagenham...

Linatex

stands to be shot at

—and always comes out best!

What material could withstand for any length of time the terrific, head-on blast of steel shot? Ford's of Dagenham know the answer—it's LINATEX! In their compressed air shot-blast cabinets and equipment, such punishment spells "curtains" for most other materials, but Linatex protective curtains with their remarkable shock absorbing capacity ride the full fury of the storm as if it were a "zephyr"! Here is further proof of the efficiency and resilience of Linatex in the toughest situations. Engineers throughout Industry, battling against wear, are finding Linatex a valuable shot in their lockers, saving its cost many times over.

Right:
A curtain of Linatex screens inner door hinge mechanism when this special shot-blast equipment is in action.

LINATEX

MAKING RUBBER WILKINSON PRODUCT SERVE INDUSTRY

95% PURE RUBBER

Non-Ageing . Tear-Resistant . Abrasion-Proof

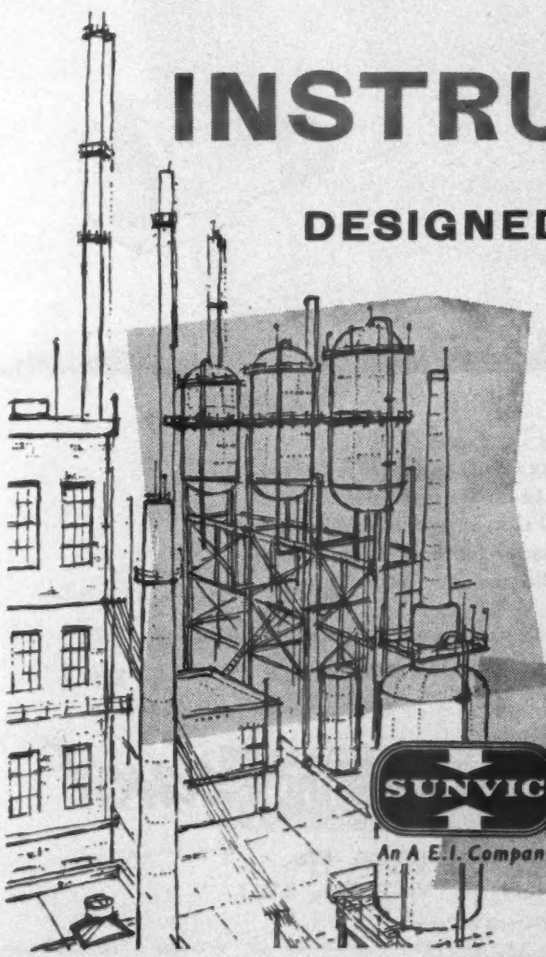
WILKINSON RUBBER LINATEX LTD
CAMBERLEY, SURREY. CAMBERLEY 1595

Factories and Distributors throughout the World

L28/G775

INSTRUMENTATION

DESIGNED FOR BRITAIN'S INDUSTRY



Sunvic—an all-British company—pioneered the introduction of pneumatic force-balance instruments to this country. Now, in addition to supplying individual instruments, we will engineer complete pneumatic/electric process measurement and control systems, including data handling. Extensive research, design and engineering resources are available to industry at all times.

SUNVIC
An A.E.I. Company

Not only instruments but complete instrumentation

for integrated monitoring, control and data handling of nuclear reactors and industrial processes.

SC/71

☐ Components and Electronic Instruments
☐ Nuclear Reactor Instrumentation
☐ Data Handling
☐ Pressure Control Instrumentation

Just tick the applications that particularly concern you, tear off this strip to your letterhead and post for further information to Sunvic Controls Ltd., P.O. Box 1, Harlow, Essex.

Permoglaze your factory

Reduce maintenance costs and increase cleanliness and efficiency in your factory by coating the walls, woodwork, steelwork and plant with PERMOGLAZE—the tile-like finish which repels dirt and is so easy to keep clean.

Its hard, glazed surface withstands damp, steam, condensation, oils, washing and hard wear. Many thousands of factories now use Permoglaze in preference to ordinary paints because it keeps cleaner, looks better and lasts longer. It is ideal for production departments, warehouses, offices, canteens and wherever hygienic conditions are important.

Grades are available to meet special problems such as mould and resistance to chemicals and corrosive conditions.

Write now for descriptive booklet, colour card and full particulars.

FREE ADVICE ON COLOUR

Write to the Permoglaze Decorative Advisory Service for expert advice on specifications and colour schemes.

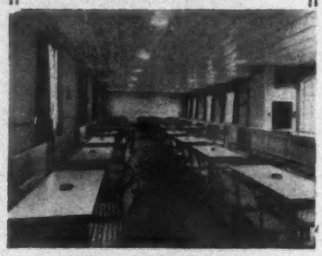
PERMOGLAZE LTD · BIRMINGHAM 11

Factories at Birmingham, Tenbury Wells, Melbourne, Sydney, and East London, South Africa. Depots at Cardiff, Leeds, Glasgow, Manchester, Nottingham and Norwich.

As good as new after nine years

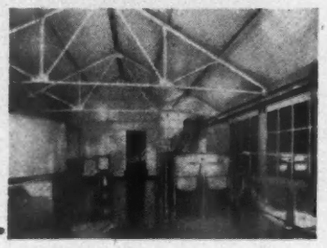
A user writes :—

"I used Permoglaze for a food processing room nine years ago. I have washed it many times and it is still as good as new."

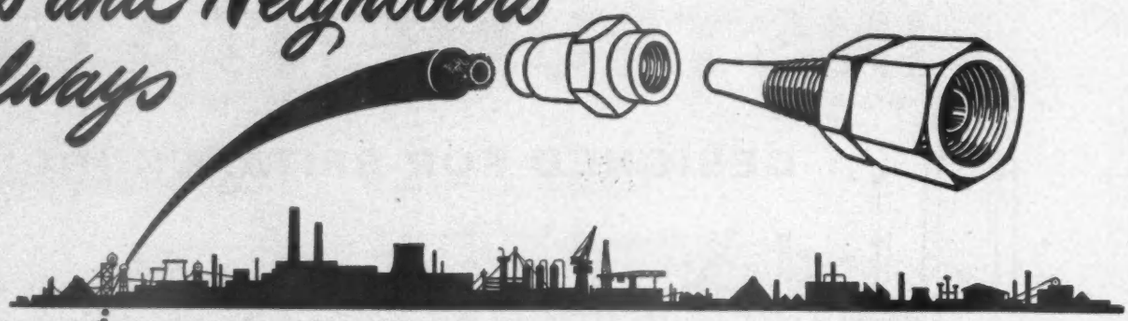


A Permoglazed Canteen.

Dairy Cooling Room treated with Permoglaze



Friends and Neighbours can't always help...



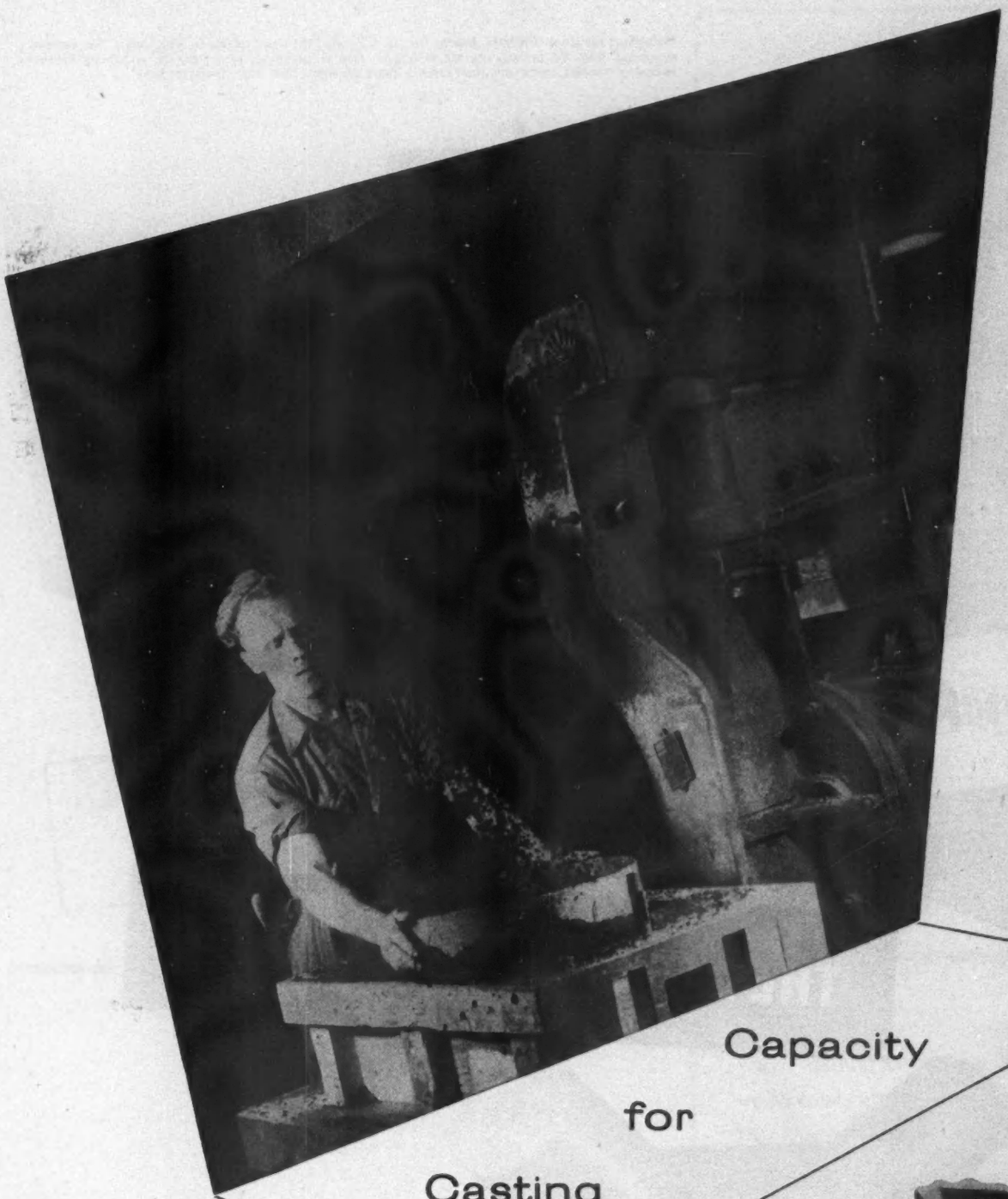
...when you've got a broken hydraulic line on your hands! But a small stock of Hi-Flex Hose and Self Fitted Couplings will enable you to make up your own Hose assemblies on the spot. Deal with emergencies as they arise and keep valuable machinery in Service.

These Hi-Flex Couplings are Self Fitted and can be re-used and are supplied in sizes from ⅛" to 1½" I/D to fit all British and American threads. Equipment requiring special ends can be supplied to customers own specification.

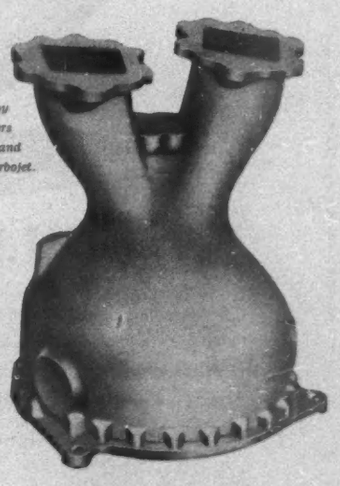
The Technical Advice of our Representatives is available to you at all times.

...but **HI-FLEX** **self-fitted couplings** *can!*

OIL FEED ENGINEERING CO. LTD.,
18, DENBIGH ST., VICTORIA, S.W.1.
Telephone : VICtoria 9807/8/9.



Capacity for Casting



Aluminium alloy expansion chambers for the De Havilland 'Ghost' Mark 1 turbojet.

Our moulding floor requires 100 tons of sand daily from the sand preparation plant. The prepared sand is distributed by belt conveyor to hoppers at the moulding stations. The photograph shows an operator riddling sand on to a pattern mounted on one of a battery of jolt, squeeze, turnover pattern draw machines in our sand foundry.

William Mills Limited

FOUNDERS IN ALUMINIUM ALLOYS

SAND CASTINGS GRAVITY DIE CASTINGS PRESSURE DIE CASTINGS

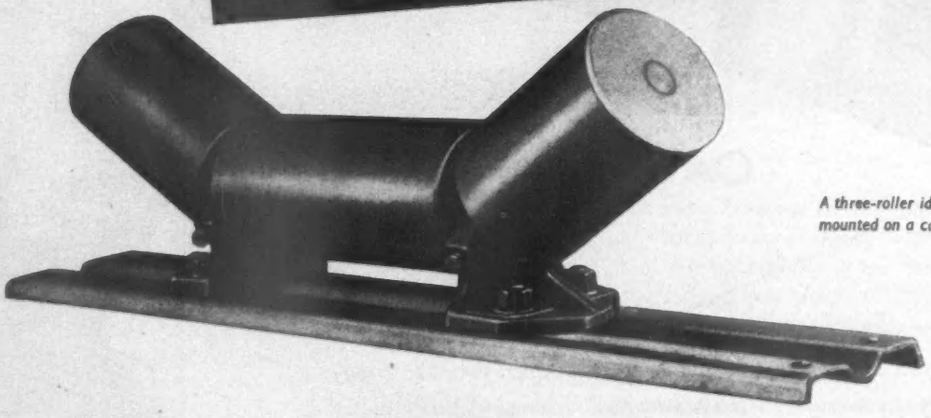
FRIAR PARK FOUNDRY, FRIAR PARK ROAD, WEDNESBURY, STAFFS

AP.117

Throughout the plant of Messrs. Judkins Ltd., at Nuneaton, the stone travels on M&C idlers. The conveyors shown run from the primary crusher to screens, then to stockpiles, then from the reclaiming tunnel to secondary crushers, and to and from screens. There are many other M&C conveyors here.

FOR IMPORTANT BELT CONVEYORS

THEY CHOOSE M&C IDLERS



A three-roller idler mounted on a corrugated idler-board.

Where belt conveyors are relied on to take the flow from faces or hoppers, crushers or screens—in fact, wherever the output depends on belt conveyors—the first choice for their support is M&C idlers. The ease with which these idlers run, year after year, in spite of dust and dirt, makes life longer for the belts and easier for the maintenance staff.

MAVOR & COULSON LTD

Bridgeton Glasgow S.E.
Olive Grove Road Sheffield 2
36 Victoria Street London S.W.1

Controlled Circulation Reheat Boiler Units

Recent contracts for steam raising units for the Central Electricity Generating Board have been designed for assisted and controlled circulation.

200 MW

Construction has started on the first of five units for HIGH MARNHAM.

550 MW

This capacity from a single boiler unit is greater than any known design in the world and will be installed at THORPE MARSH.

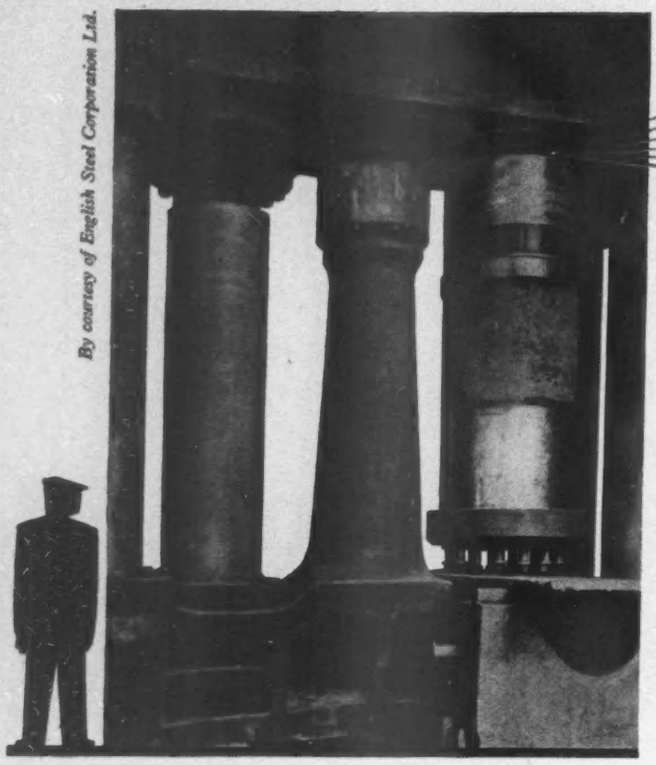
Many natural circulation units are also under construction for electrical generation and industry in many parts of the world.

INTERNATIONAL COMBUSTION LIMITED

LONDON OFFICE: NINETEEN WOBURN PLACE, WC1 · TEL: TERMINUS 2833 · WORKS: DERBY

MEMBER OF ATOMIC POWER CONSTRUCTIONS LIMITED

One of the five British Nuclear Energy Groups



By courtesy of English Steel Corporation Ltd.

for shrink-fitting...
the 'Drikold' way is best

'Drikold' — I.C.I.'s solid carbon dioxide — provides the ideal method of producing interference fits without applying heat or pressure. And experience has shown that the 'Drikold' method is suitable for large-scale operations. The illustration shows a 7-ton cylinder which was successfully cooled by 'Drikold' and shrunk into the entablature above it. Two forged steel bushes, each weighing more than 1 cwt, were also shrunk into the entablature. 'Drikold' is a convenient, clean, dry, low-temperature refrigerant, whose use requires only simple equipment.

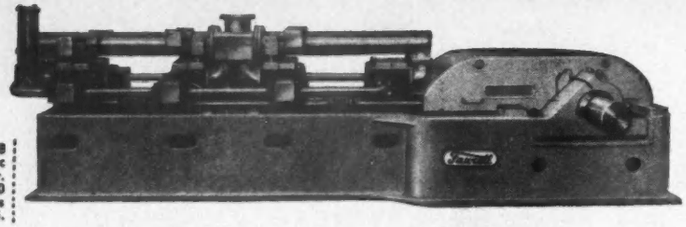
DR.255 ICI

Full information from:
Imperial Chemical Industries Ltd.
London, S.W.1

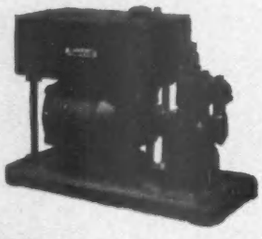
Fawcett

Hydraulic Pumps for all Industrial Applications

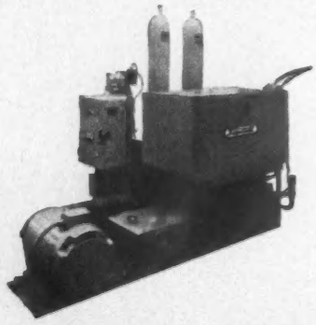
constant and variable pressures



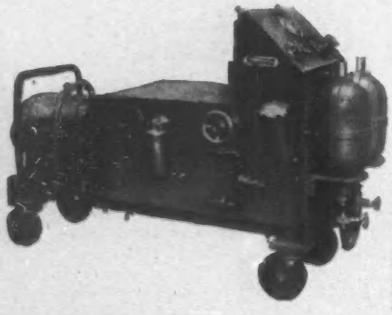
Horizontal 4, 6 or 8 plunger type hydraulic pump for water. Speeds up to 300 r.p.m. and pressures up to 6,000 p.s.i.



"S" TYPE PUMP OF THE RECIPROCATING TYPE. Capacity 65 cubic inches per minute at 5,600 lbs. per square inch. Variable pressure control. 1 H.P. ELECTRIC MOTOR AT 1,440 R.P.M. Also VALVES TO SUIT ALL REQUIREMENTS.



Fawcett high pressure pumps for oil and water are made for constant and variable pressures with volumes from ¼ g.p.m. up to 200 g.p.m. and may be supplied complete with Greer-Mercier Hydro-pneumatic Accumulator stations to meet your particular requirements. We will gladly supply further details on any of the types of pumps illustrated and be pleased to advise on units designed to your needs and specifications.

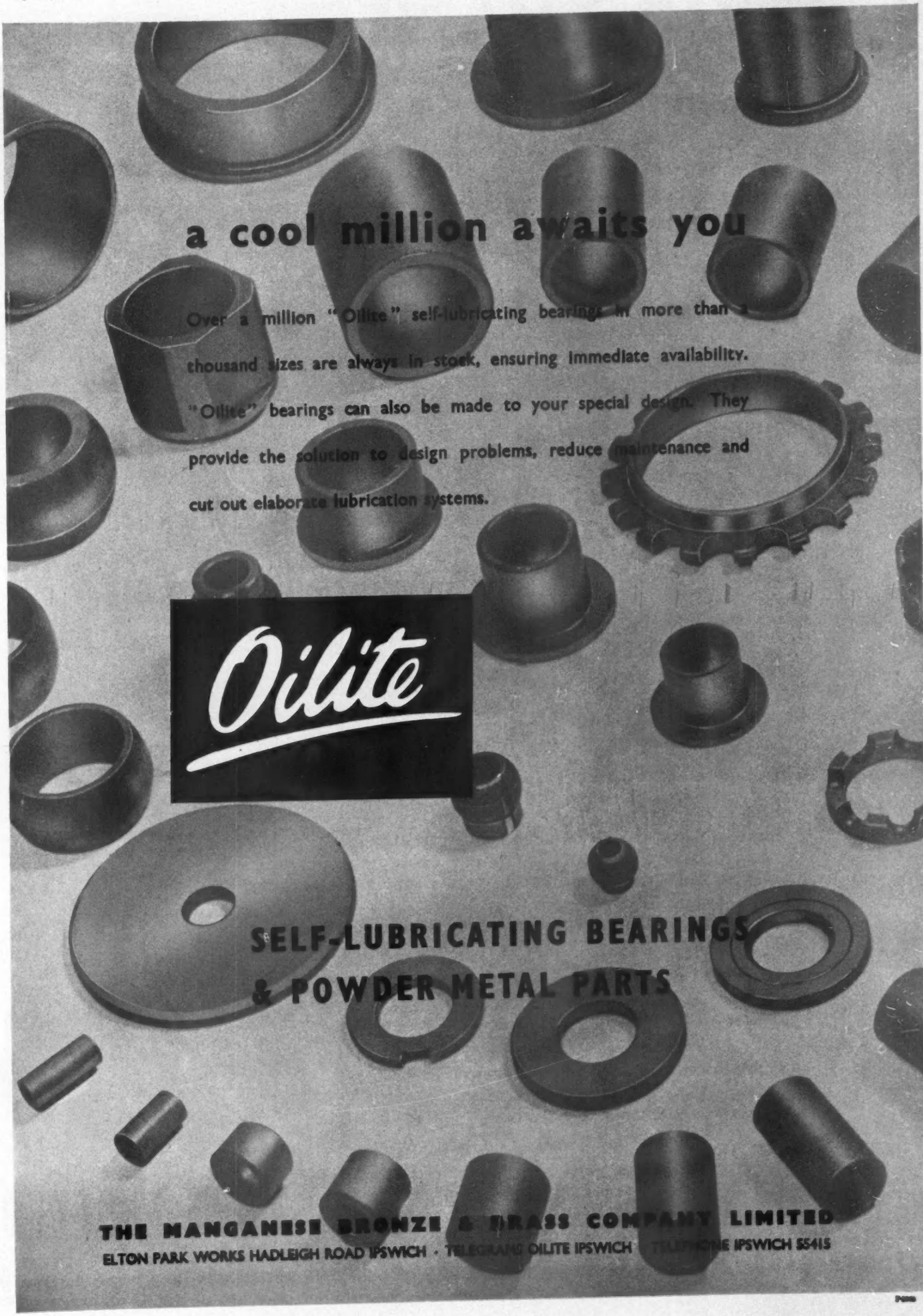


Horizontal 4 ram pump for water with central power unit embodying two 8 gallon Greer-Mercier hydro-pneumatic accumulators. Working pressures up to 5,000 p.s.i.

Mobile pump unit for oil for test rig purposes. Pressures up to 5,000 p.s.i. and volumes up to 6 g.p.m. Incorporates two 2-gallon Greer Mercier Hydro-pneumatic accumulators.

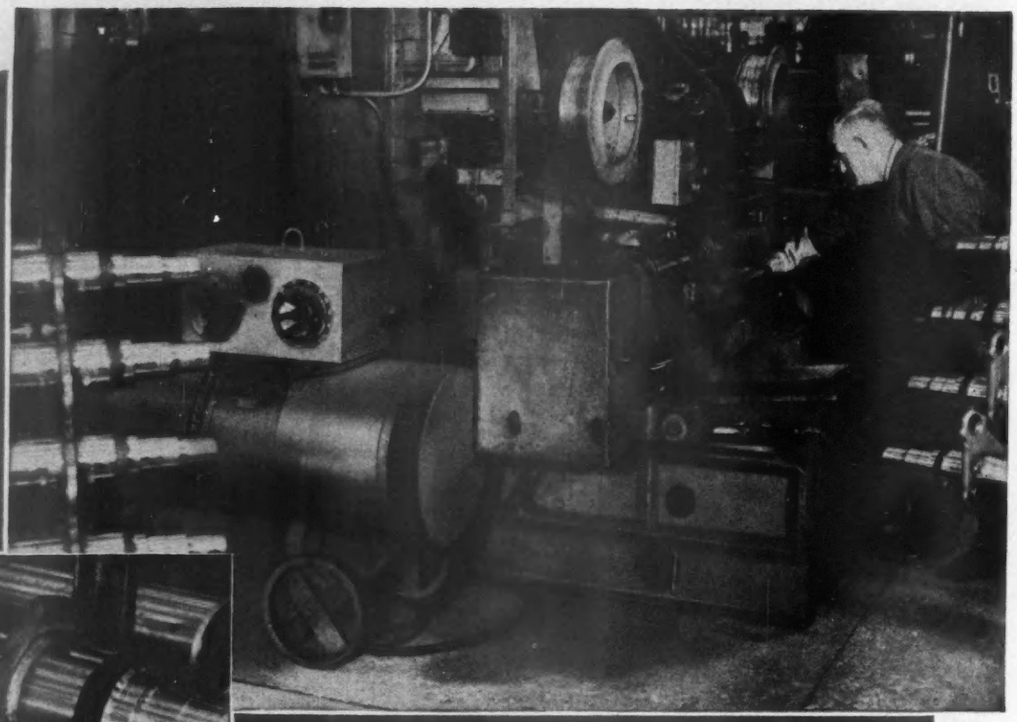
FAWCETT PRESTON & COMPANY LIMITED
(Incorporating FINNEY PRESSES)
BROMBOROUGH · CHESHIRE
Telephone: Rock Ferry 2201 · Telegrams: "Fawcett Bromborough"
Branch Offices in London, Birmingham & Glasgow.
A member of the Metal Industries Group of Companies

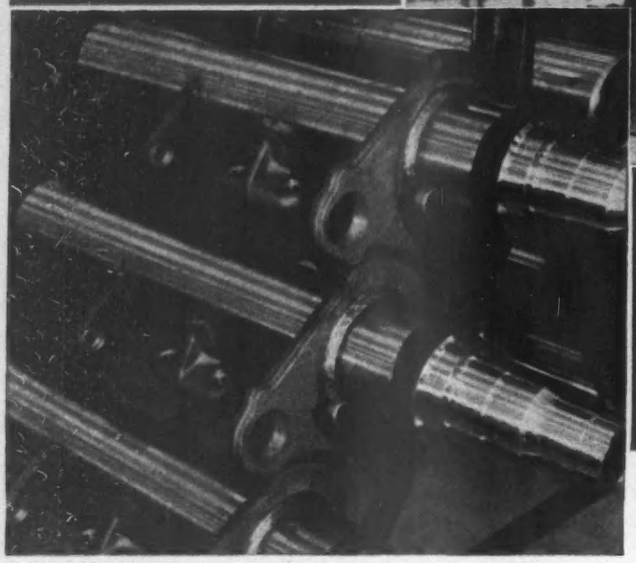
97/100.


a cool million awaits you
Over a million "Oilite" self-lubricating bearings in more than a thousand sizes are always in stock, ensuring immediate availability. "Oilite" bearings can also be made to your special design. They provide the solution to design problems, reduce maintenance and cut out elaborate lubrication systems.
Oilite
SELF-LUBRICATING BEARINGS & POWDER METAL PARTS
THE MANGANESE BRONZE & BRASS COMPANY LIMITED
ELTON PARK WORKS HADLEIGH ROAD IPSWICH · TELEGRAMS OILITE IPSWICH · TELEPHONE IPSWICH 55415

FIRST IN THE FIELD—AND STILL IN THE LEAD

LINCOLNWELD SPEEDS PRODUCTION!





at Vauxhall Motors Limited, Dunstable

Specially Adapted Lincoln Submerged Arc Automatic Welding Units, continuously welding brake support plates to rear axle tube assemblies for Bedford Commercial Vehicles and Trucks.

This installation speeds Vauxhall Motors' production and shows substantial savings over previous hand welding methods.

Let us advise you on YOUR production problems!

Write to The Automatics Division.

LINCOLN ELECTRIC COMPANY LIMITED

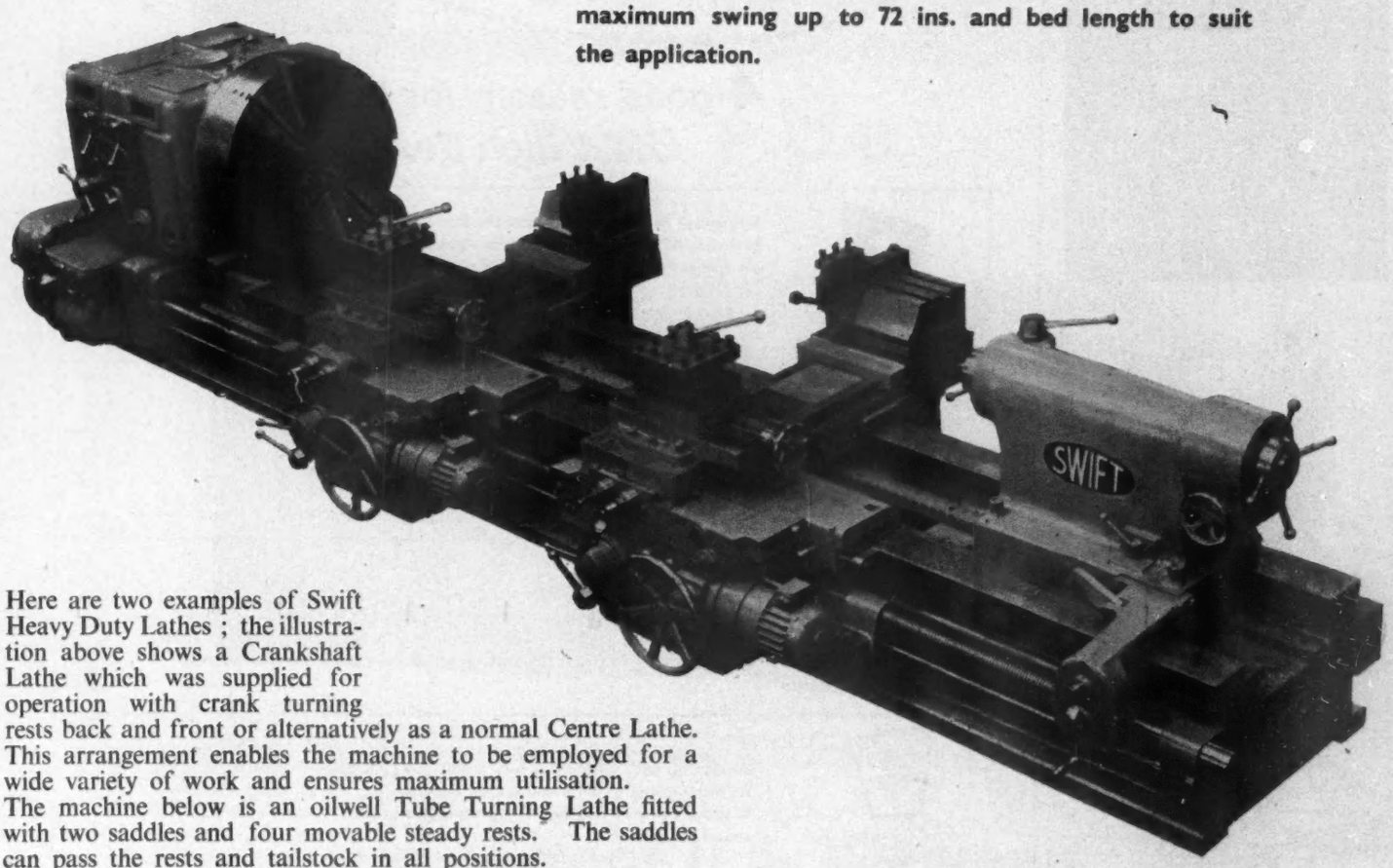
WELWYN GARDEN CITY · HERTS · WELWYN GARDEN 920 (5 lines) 4581 (5 lines)

SM107A

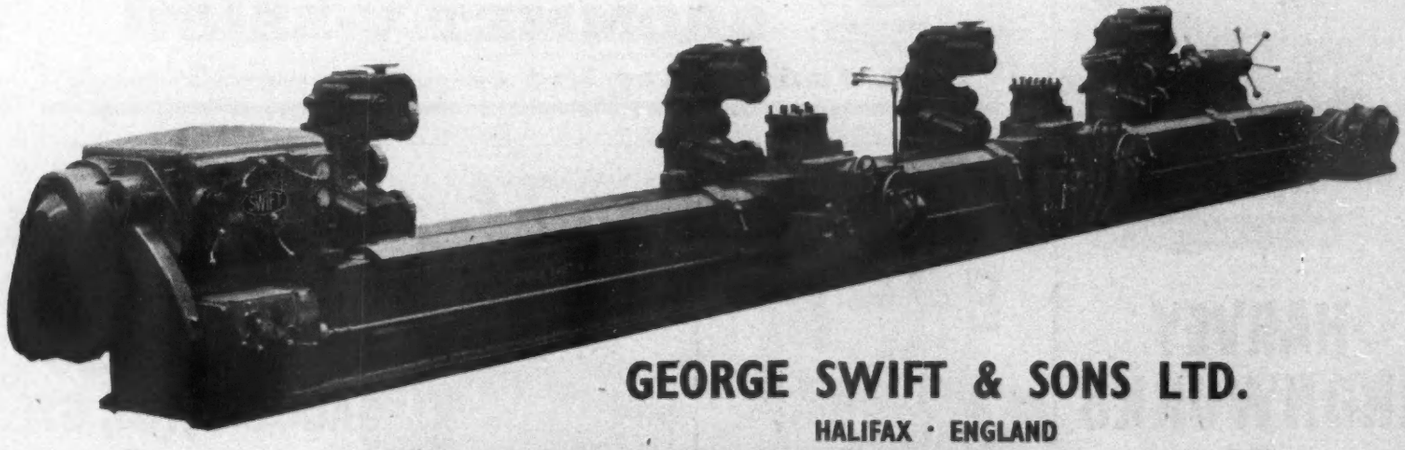
SWIFT

HEAVY DUTY LATHES

manufactured in a wide range of standard types with maximum swing up to 72 ins. and bed length to suit the application.



Here are two examples of Swift Heavy Duty Lathes ; the illustration above shows a Crankshaft Lathe which was supplied for operation with crank turning rests back and front or alternatively as a normal Centre Lathe. This arrangement enables the machine to be employed for a wide variety of work and ensures maximum utilisation.
The machine below is an oilwell Tube Turning Lathe fitted with two saddles and four movable steady rests. The saddles can pass the rests and tailstock in all positions.
If you have a special problem in connection with turning large workpieces or simply require a standard Centre Lathe, a modern Swift Lathe can probably meet your requirements.
Write to Drummond-Asquith (Sales) Ltd. for further information.



GEORGE SWIFT & SONS LTD.

HALIFAX · ENGLAND

Sales & Service for . . . **DRUMMOND-ASQUITH** *. . . the British Isles*

DRUMMOND-ASQUITH (SALES) LTD., KING EDWARD HOUSE, NEW ST., BIRMINGHAM

'Phone : Midland 3431 (7 lines) 'Grams : Maxishape, B'ham. Also at LONDON : Phone : Trafalgar 7224 (5 lines) and GLASGOW : 'Phone : Central 0922

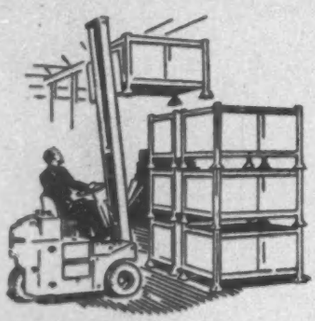
S 175

M

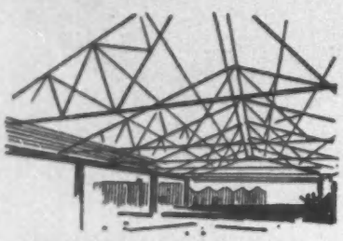
HARVEY IRONWORKS

INVITE ENQUIRIES FOR

PLANT HANDLING EQUIPMENT, WELDED FABRICATIONS AND PLATE WORK (TANKS, ETC.) TO SPECIFICATION



PALLETS



ROOF TRUSSING

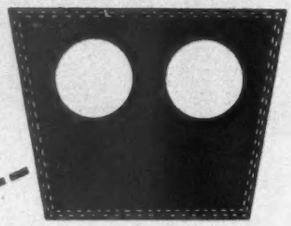
METAL PARTITIONING

HARVEY IRONWORKS LTD.

337 HOLYHEAD ROAD,
HANDSWORTH, BIRMINGHAM 21
Tel: WEST BROMWICH 2193

---

the **GROMMET** story



4 *good reasons for fitting* ***BTR High Test*** **V-BELTS**

1 HIGHER HORSEPOWER

Grommet construction makes the most efficient use of high tensile cords to produce the strongest V-belts yet made. For grommet construction ensures that *all* the cords of a belt share the load *equally* — which is the condition for maximum transmitting efficiency. Furthermore, a grommet, being an endless loop of high tensile cords, has no joints to weaken the belt, no overlapping sections to stiffen it.

2 MORE GRIPPING POWER

Grommet construction ensures that the belt exerts full driving grip on the walls of the pulley groove, for there are no central cords to dip and 'dish' the belt, pulling it away from the walls under load. This extra driving grip allows heavier loads and prevents belt slip.

3 MORE OUTPUT FOR ELECTRICITY CONSUMED

Despite its superior strength, a grommet is the most flexible V-belt load carrying device yet developed. Thus the belt runs cool and absorbs minimum energy in flexing around the pulleys. This saving in power appears in extra pay-load for electricity consumed.

4 LONGER BELT LIFE

Operating with a higher safety factor than ordinary V-belts, BTR grommet V-belts last longer because they are stronger and also because being so flexible they are subject to little strain in flexing round the pulleys.

BTR ENGINEERS IN RUBBER

BTR HIGH TEST GROMMET V-BELTS

Patented in Great Britain by BTR Patent No. 567406

BTR Industries Ltd HERGA HOUSE, VINCENT SQUARE, LONDON S.W.1 *Telephone: VICtoria 3848*

D1359

Special Purpose Machines

FAIRMAN PRECISION TOOLS AND PRODUCTS LIMITED

PRESS TOOLS PROTOTYPES MOULDS GAUGES, JIGS, ETC.

Phone : 3678

STATION RD (EAST), HORLEY, SURREY

A.I.D., M.O.S., & ADMIRALTY APPROVED

METROVICK

Pneumatic-Electric Converter

Type P.C.8

the perfect link between pneumatic & electronic control systems

The Type P.C.8 Pneumatic-Electric Converter has been designed primarily as a link between pneumatic and electrical control systems where standard units in the two control mechanisms need to be combined. The input pressure is the normal 3-15 p.s.i. gauge used in process controllers and the output voltage (100 V max.) is suitable as, for instance, a reference voltage for most commercial motor speed controls. Other applications include conversion of air pressures for electrical recording.

Write for leaflet No. ES4566/2

METROPOLITAN-VICKERS
ELECTRICAL CO LTD TRAFFORD PARK MANCHESTER, 17

An A.E.I. Company

INDUSTRIAL PROCESS CONTROLS

R/E 703

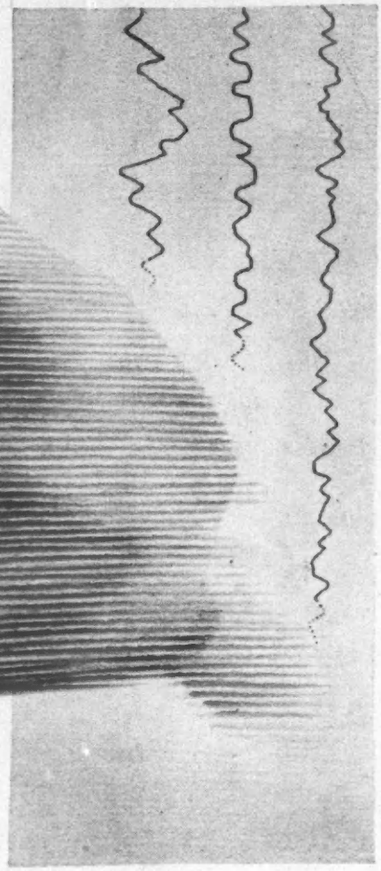
CAPTURE

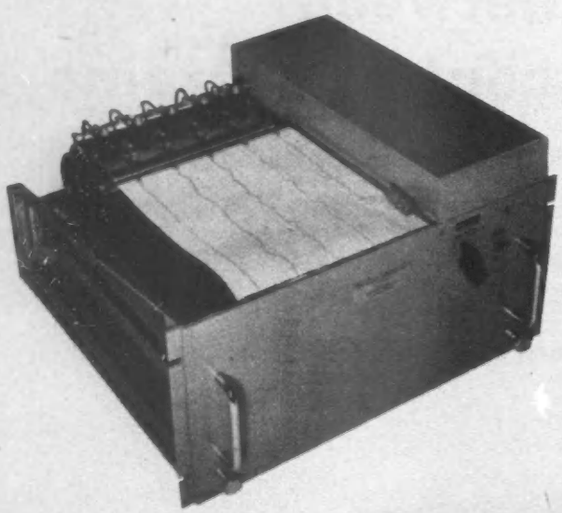
TRANSIENT PHENOMENA FOR GOOD WITH

KH

High-speed

PEN RECORDERS





Continuous recording of rapid, transient or oscillatory phenomena is made possible with Kelvin Hughes High Speed pen recording instruments. A wide range of instruments is available including new units which will permanently record up to 8 variables simultaneously. When used in conjunction with special Kelvin Hughes bridge amplifiers and power units, the recorders will measure strain, force, displacement, drag, pressure, acceleration and similar variables, providing instantaneous permanent recordings. Rapid response, versatility and dependability make them well suited for research work in aerodynamics, rockets, hydraulics, computers, and countless applications in industry, including civil engineering, mining, production testing of motor cars and tractors.

Ruggedly built and insensitive to external vibrations, Kelvin Hughes pen recorders will operate effectively under the most exacting conditions in vehicles, aircraft, and where heavy industrial plant is operating.

KH

Please write for technical literature. Kelvin Hughes specialists are freely available to advise on any particular application for single- or multi-channel recorders in industry.

KELVIN HUGHES

SPECIALISTS IN INDUSTRIAL MEASUREMENT

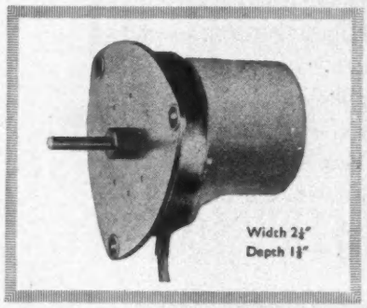
KELVIN & HUGHES (INDUSTRIAL) LIMITED, 2 CAXTON STREET, LONDON, S.W.1

60-72 Kelvin Avenue, Hillington, Glasgow, S.W.2

TGA KH878

THIS is the motor

FOR SEQUENCE SWITCHING, CHART RECORDERS, PROCESS CONTROLLERS, INSTRUMENTATION, AUTO-LUBRICATION, etc.



★ SELF STARTING
★ CONSTANT SPEED
★ YEARS OF RELIABLE SERVICE
★ WIDE VARIETY OF SPEEDS
★ COMPETITIVE PRICE

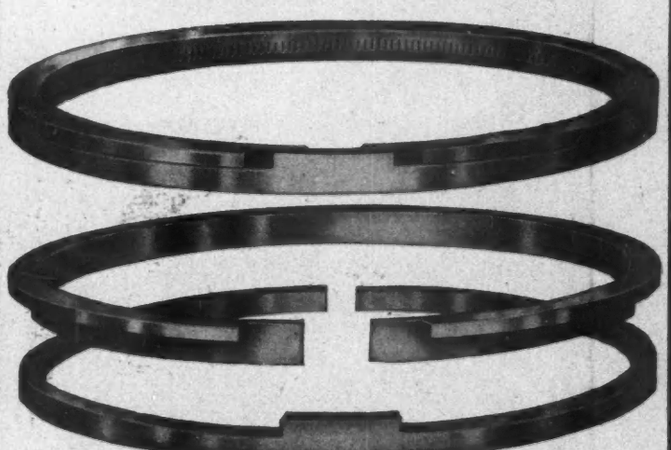
Sintered bronze rotor bearings ensure long life. Power consumed 2 watts. Write or telephone now for full details of this compact, totally enclosed LIGHT DUTY Motor Unit.

SMITHS

CONSTANT SPEED MOTORS

SMITHS CLOCK & WATCH DIVISION
CONTRACTS BRANCH, 179 GREAT PORTLAND STREET, LONDON, W.1. LANgham 5811

STANDARD'S TRIPLE SEAL PISTON RINGS



EFFECTIVELY SEAL THREE FACES

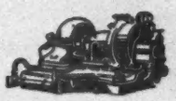
Eliminate by-pass, Restore compression, Maintain full power, Function until bore of cylinder is worn by as much as 1%.

THE
STANDARD PISTON RING & ENGINEERING CO., LTD

PHONE: Sheffield 42076-7-8 (three lines). DON ROAD, SHEFFIELD, GRAMS: OCEAN SHEFFIELD.
London Office: Walter C. Jones, M.I.Mech.E., M.I.Mar.E., 57-58, Gresham House, Bishopsgate, E.C.2 (London Wall 6981)

BROTHERHOOD

VERTICAL AND HORIZONTAL
STEAM TURBINES

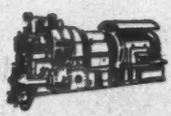


Wide range — all types. Over 50 years' experience. **Hundreds in hand—thousands in service.**

BROTHERHOOD
COMPRESSORS

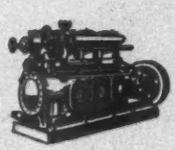
Air, Gas, and Refrigerating. The widest range in the British Empire — made to suit your requirements. **Thousands in service.**

BROTHERHOOD
GENERATING SETS



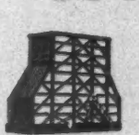
Turbine driven up to 11,000 KW. Engine driven up to 340 KW. **Scores in hand, hundreds in service.**

BROTHERHOOD
REFRIGERATING PLANT



Ammonia, CO_2, Freon, Methyl. Chloride, SO_2. Wide range—single and double acting—one or more stages. **Made to measure for special duties.**

BROTHERHOOD
COOLING TOWERS

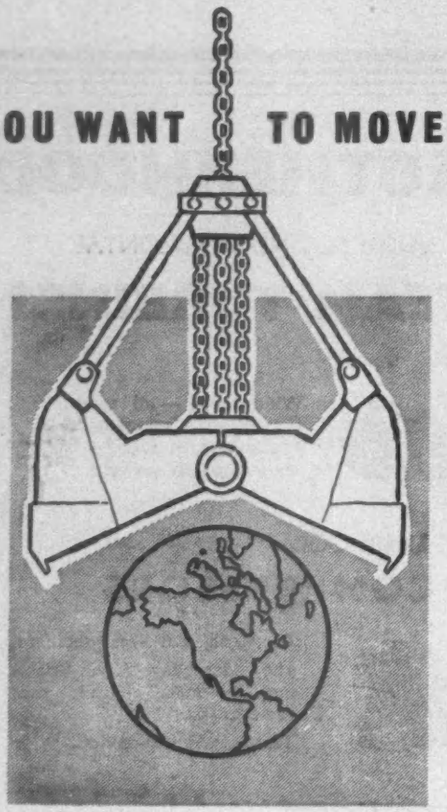


All types. Nearly 50 years' experience.

also Manufacturers of all kinds of
PLANT TO CUSTOMERS' OWN DESIGNS
WHY NOT SEND YOUR PROBLEMS TO US?
We shall be pleased to investigate them confidentially without commitment

BROTHERHOOD
PETERBOROUGH ENGLAND
COMPRESSOR & POWER PLANT SPECIALISTS FOR NEARLY A CENTURY

IF YOU WANT TO MOVE THE EARTH—FIT FERODO



All types of earth moving machinery—from dumpers to excavators —use safe, tough Ferodo Brake Linings and Clutch Facings to control and transmit power. Ferodo materials have hard-wearing qualities that have been developed and perfected—during half a century—in the Ferodo Test House. You can be sure of long life and first class performance from every kind of Ferodo Lining—so with fewer replacements, you'll cut operating costs! Send for the detailed catalogues of Ferodo Brake and Clutch Linings.

FERODO
BRAKE LININGS
CLUTCH FACINGS

FERODO LIMITED · CHAPEL-EN-LE-FRITH *A Member of the Turner & Newall Organisation*

E IRON CASTINGS

HALF BRAKE DRUM SIDE
16' 8" DIA., 5 TONS, 12 CWTS

Reproduced by kind permission of
M. B. WILD & CO., LTD.,
BIRMINGHAM.

For CASTINGS & PATTERNS OF MACHINE TOOL QUALITY CONSULT:

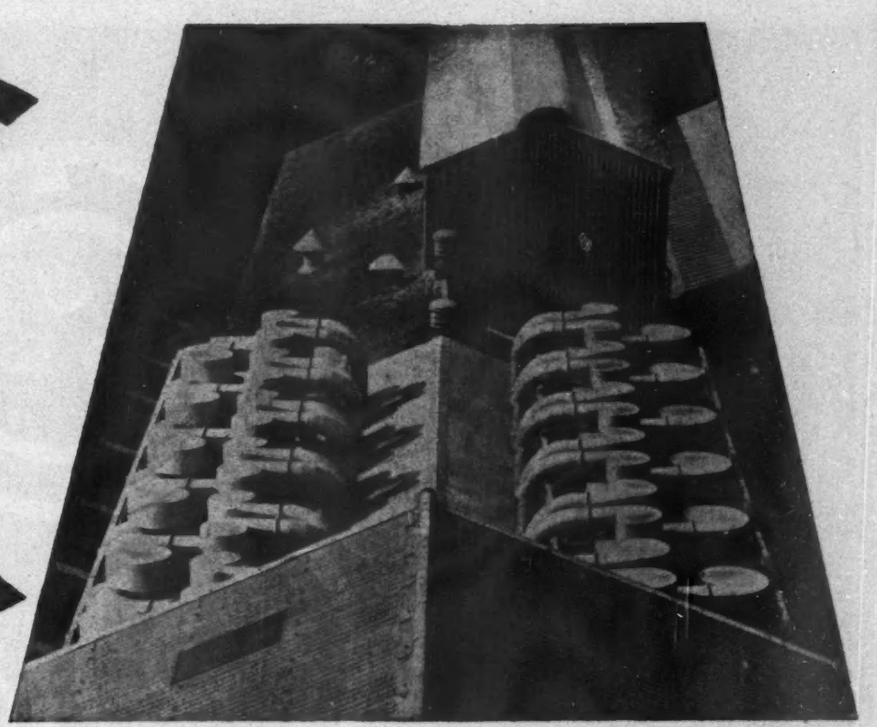
ENTWISLE & GASS LTD

DEPT. 'C' · NELSON STREET
BOLTON · LANCS
Phone: 5967-8

MACHINING CAPACITY ALSO AVAILABLE

BRABY

for Metal Plate and Sheet Metal Fabrications



Aero Jet Engine Test Cell Silencer. One of three sets for Royal Danish Air Force (Made by BRABY for their subsidiary company, Maxim Silencers Limited).

Mild Steel Plate Cyclones and Ducting supplied and erected at large Cattle Feed Mill in London.

Pressure Cylinder supplied to Mono Pumps Limited.

BRABY, with six factories located in widely separated parts of Great Britain, have, for more than 100 years, specialised in Metal Plate and Sheet Metal Work.

The technical knowledge and experience of our Staff and the employment of a labour force of skilled craftsmen, enable Braby to provide for Industry an efficient Metal Plate and Sheet Metal Work manufacturing service.

We welcome your enquiries.

ONE OF THE WIDE RANGE OF

BRABY

PRODUCTS

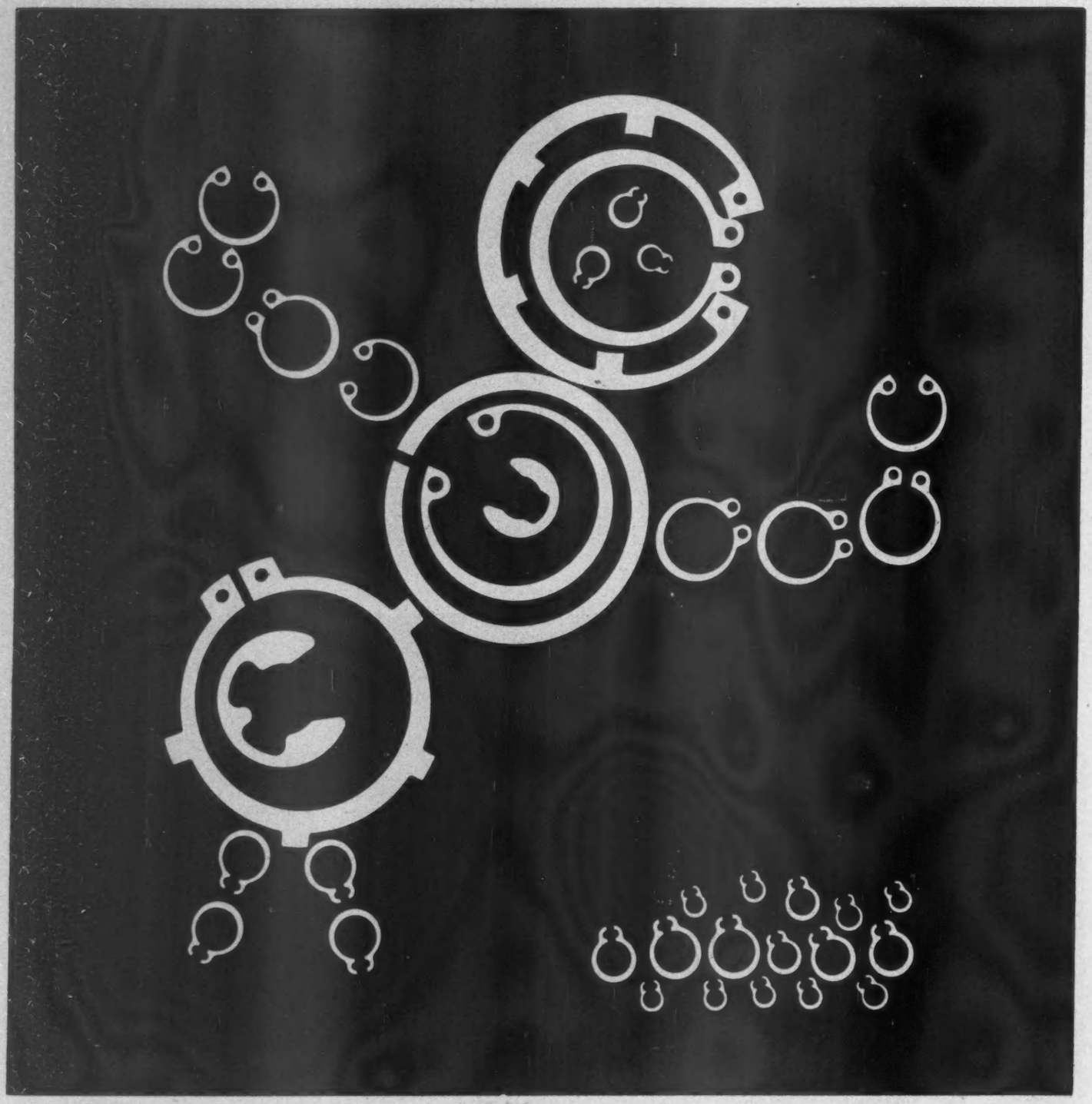
FREDERICK BRABY & COMPANY LIMITED

Head Office: 352-364 EUSTON ROAD, LONDON, N.W.1. TELEPHONE: EUSton 3456

FACTORIES AT: London Works, Thames Road, Crayford, Kent. TELEPHONE: Bexleyheath 7777
Havelock Works, Aintree, Liverpool, 10. TELEPHONE: Aintree 1721
Eclipse Works, Petershill Road, Glasgow, N. TELEPHONE: Springburn 5151
Ashton Gate Works, Bristol, 3. TELEPHONE: Bristol 64061. And Falkirk

OTHER OFFICES: 110 Cannon Street, London, E.C.4 (Export). TELEPHONE: MANsion House 6034
Queen's Buildings, 10 Royal Avenue, Belfast. TELEPHONE: Belfast 26509
Palace Street, Plymouth. TELEPHONE: 62261

A.P. 90

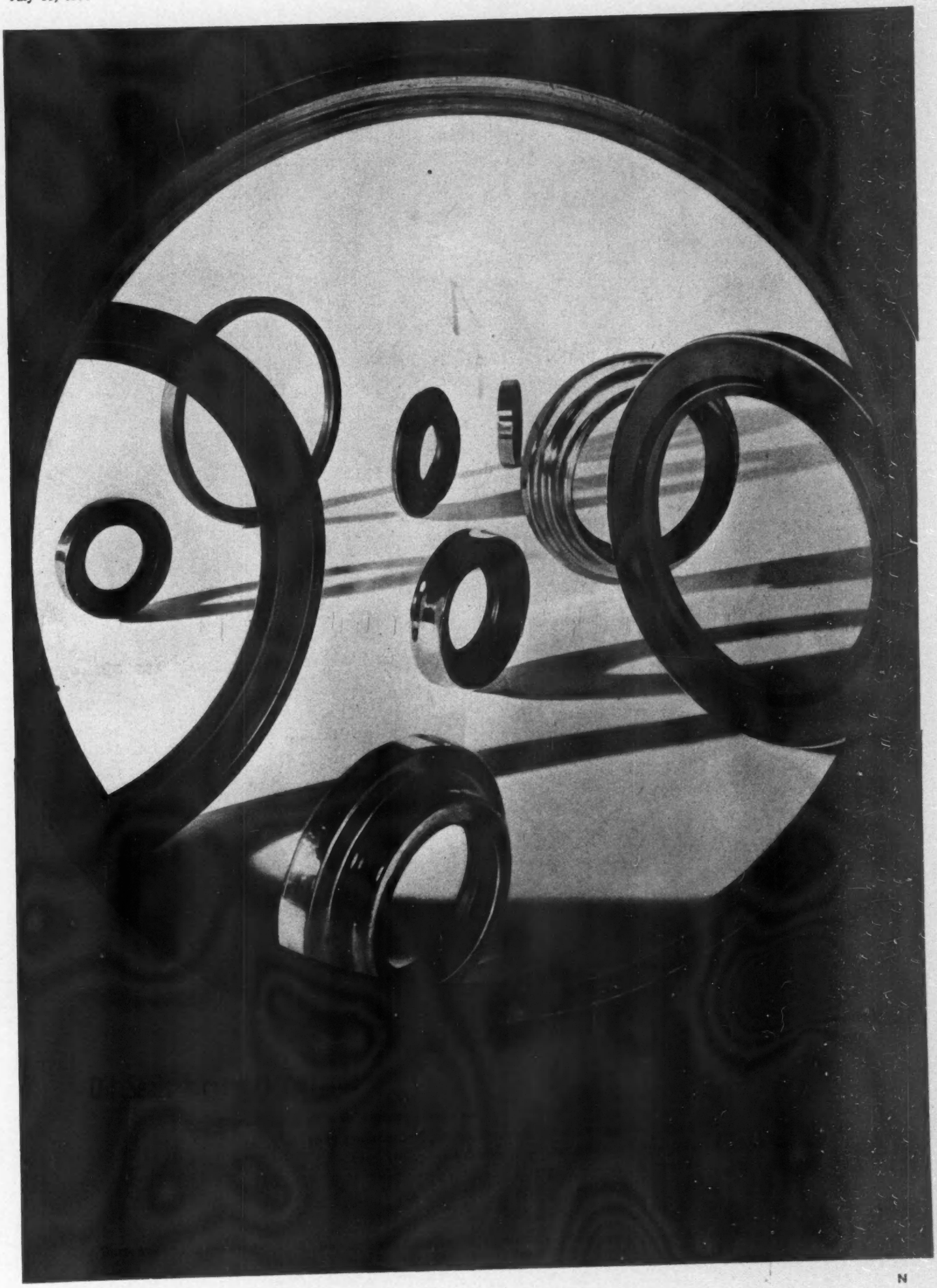


"SEEGER CIRCLIPS . . .

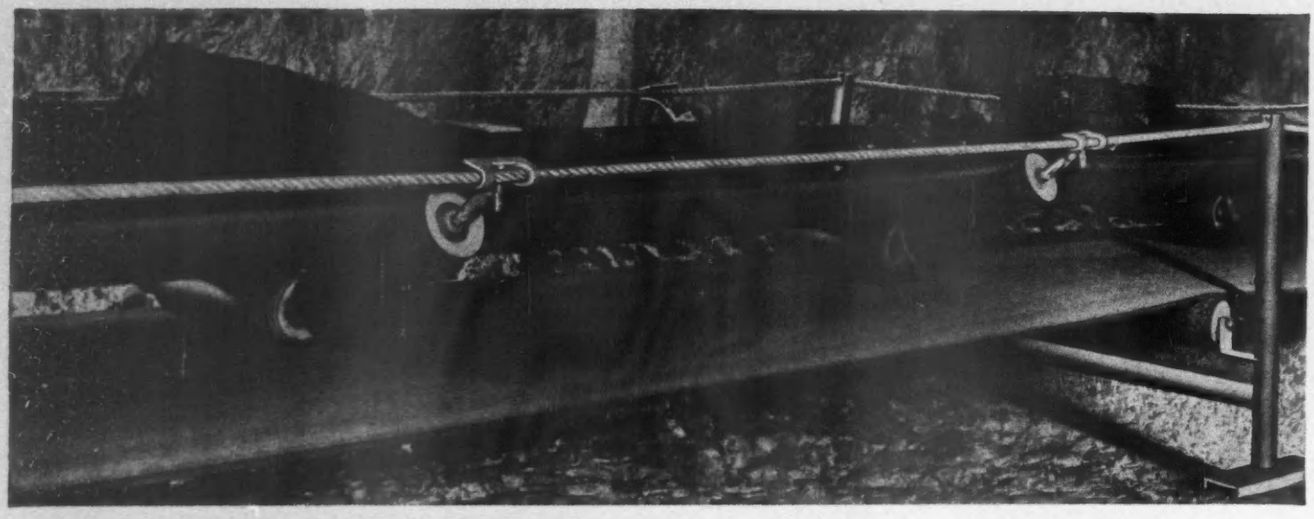
easy to fit and **360° safe!"**

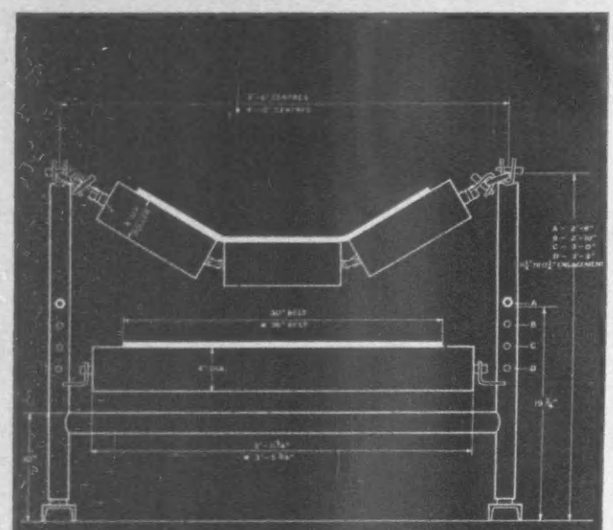
Automotive Engineering Limited

One of the Sheepbridge Engineering Group
The Green, Twickenham, Middlesex.
Telephone : Popesgrove 2206/9 Telegrams : Motif, Twickenham

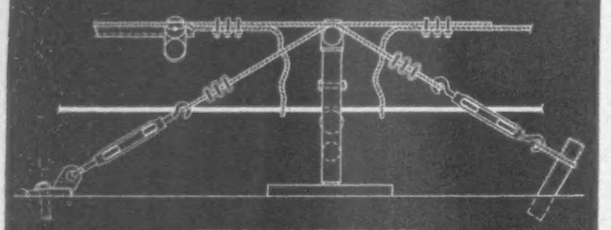


N





INTERMEDIATE STAND
(Adjustable for height)



TYPICAL ANCHORAGES

NEW RESILIENT

Distington - Goodman

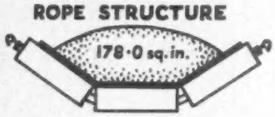
BELT CONVEYOR STRUCTURE

(Patented)

- ***— increases belt life***
- ***— reduces installation costs***
- ***— increases capacity***
- ***— almost eliminates spillage***
- ***— inexpensive***

CONVENTIONAL STRUCTURE

ROPE STRUCTURE



Greater conveying capacity obtainable by increased troughing under load

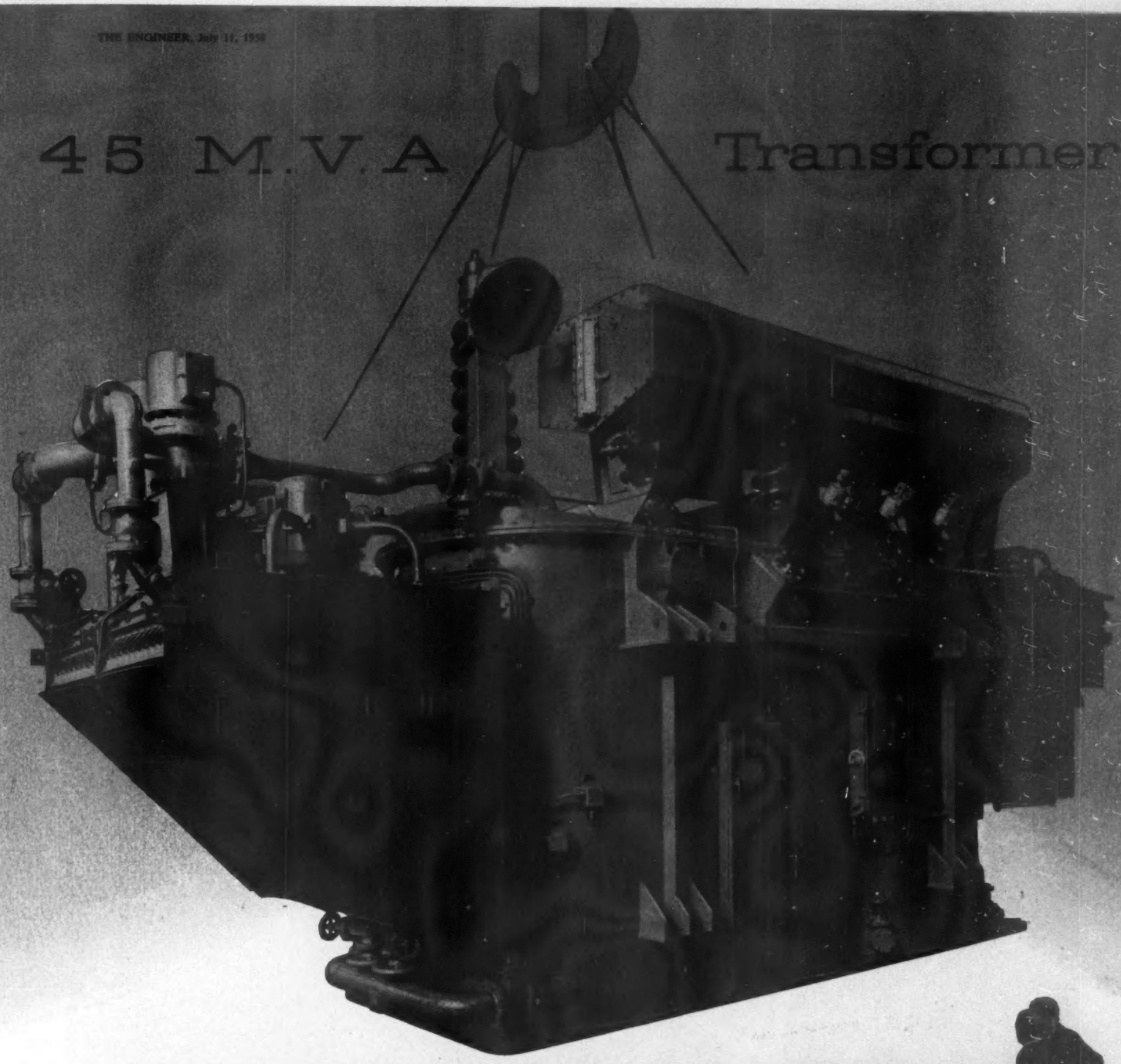
The longitudinal members of this conveyor structure consist of ⅝" dia. steel ropes in tension. The connections at the ends of each troughing idler shaft are hinged. These basic features provide a resilient conveyor which is easy to stack, transport and install — a conveyor in which impact damage to the belt as it passes over the idlers is greatly reduced. The belt is easy to train. The bottom belt is in full view and there need not be any concealed rubbing between belt and structure.

DISTINGTON

DISTINGTON ENGINEERING COMPANY LIMITED
WORKINGTON CUMBERLAND ENGLAND

BC8

45 M.V.A Transformer

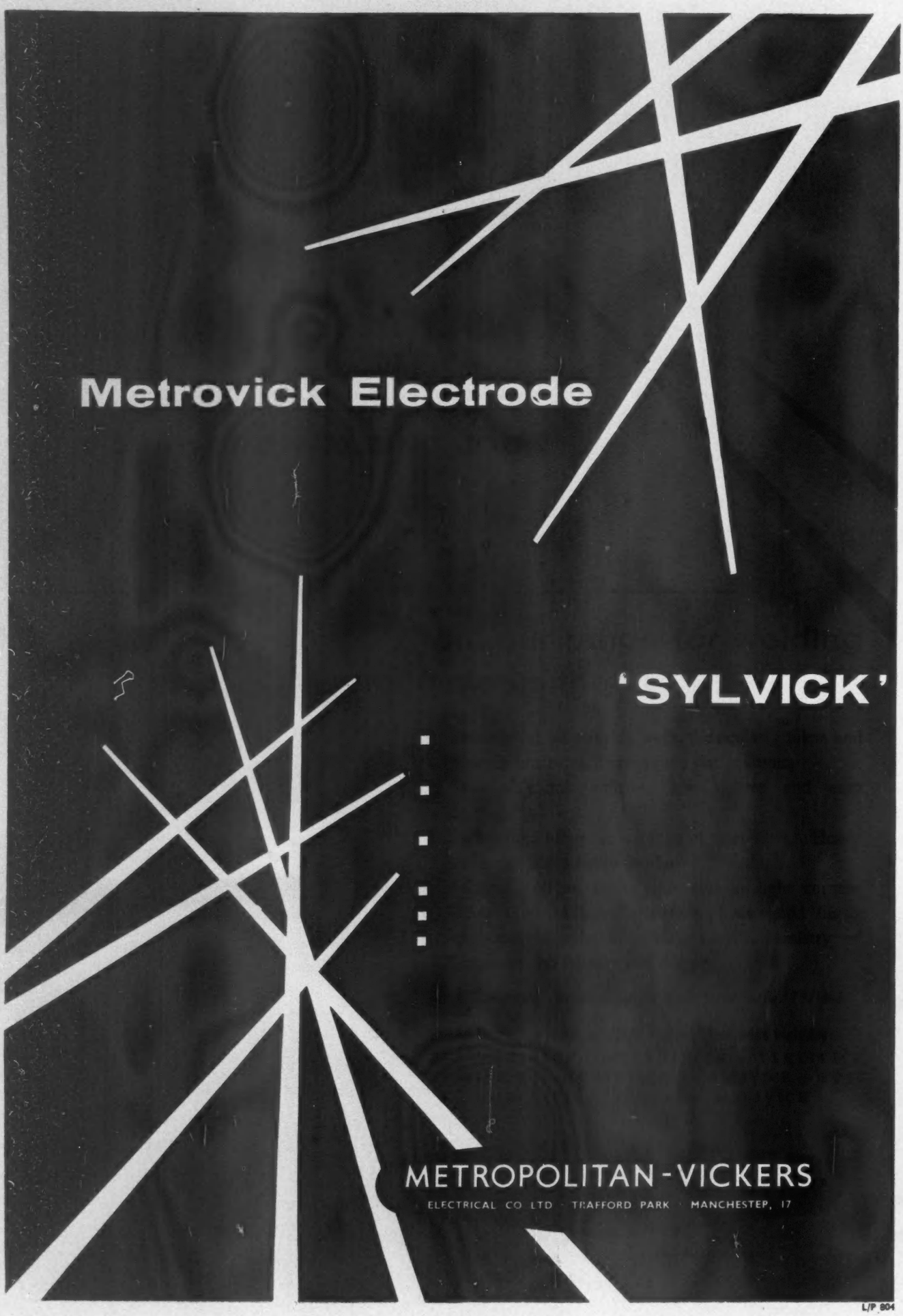


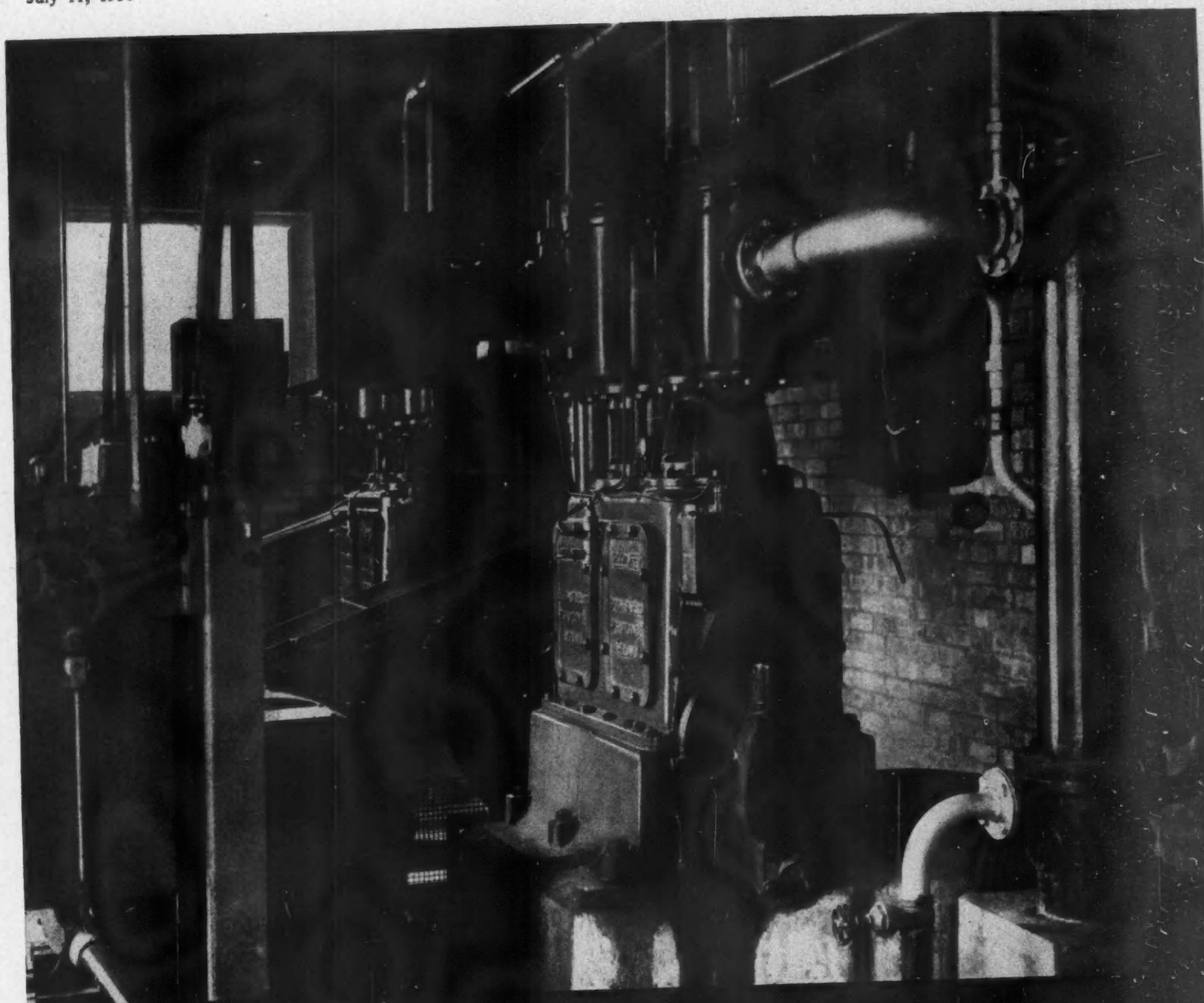
...fully transportable

To meet a C.E.G.B. requirement for stand-by transformers which are readily transportable to required locations, Parsons have manufactured 45 MVA 3 phase 132 kV transformers, each transformer a compact single unit. They are big—as transformers of this capacity must be—but *not too big* to be lifted bodily and transported by road or rail to where they may be required.

PARSONS

C. A. PARSONS & COMPANY LIMITED · HEATON WORKS · NEWCASTLE UPON TYNE 6


Metrovick Electrode
'SYLVICK'
METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17
L/P 804



"BROOMWADE"

579 SAS

Twisting, scuffing, oil and sun have little effect on this hose

Way up in dependability, way down in replacement costs—that's the story of hose made of Du Pont neoprene.

Neoprene tubes are flexible, resist the attack of oil in the line. As a result, they stay smooth, won't crumble and clog vital tool parts.

Covers of neoprene protect the fabric of the hose when it is dragged and twisted over sharp and abrasive objects. The neoprene covers give lasting protection because neoprene resists the deteriorating effects of oil and grease, sunlight and weather.

This double-duty protection, inside and out, is the reason why neoprene cover and tube are used as original equipment on most compressed air hose. The next time you order hose, be sure to specify Du Pont neoprene for extra-long service life.

FREE! "*The Du Pont Elastomers Notebook*". This booklet describes the many properties of Du Pont elastomers, and how they may be used to improve products and cut replacement and maintenance costs. Send coupon for it now.

DU PONT
REG. U. S. PAT. OFF.

NEOPRENE

Better Things for Better Living . . . through Chemistry

For more information about locally manufactured products made of Du Pont Neoprene, write:

Distributors DU PONT COMPANY (UNITED KINGDOM) LTD., 6 CHARLES II STREET, LONDON, S.W.1.
Sales Agents DURHAM RAW MATERIALS LTD., 131 GREAT TOWER STREET, LONDON, E.C.3.

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Department, E.58,
Export District, Wilmington 98, Delaware, U.S.A.

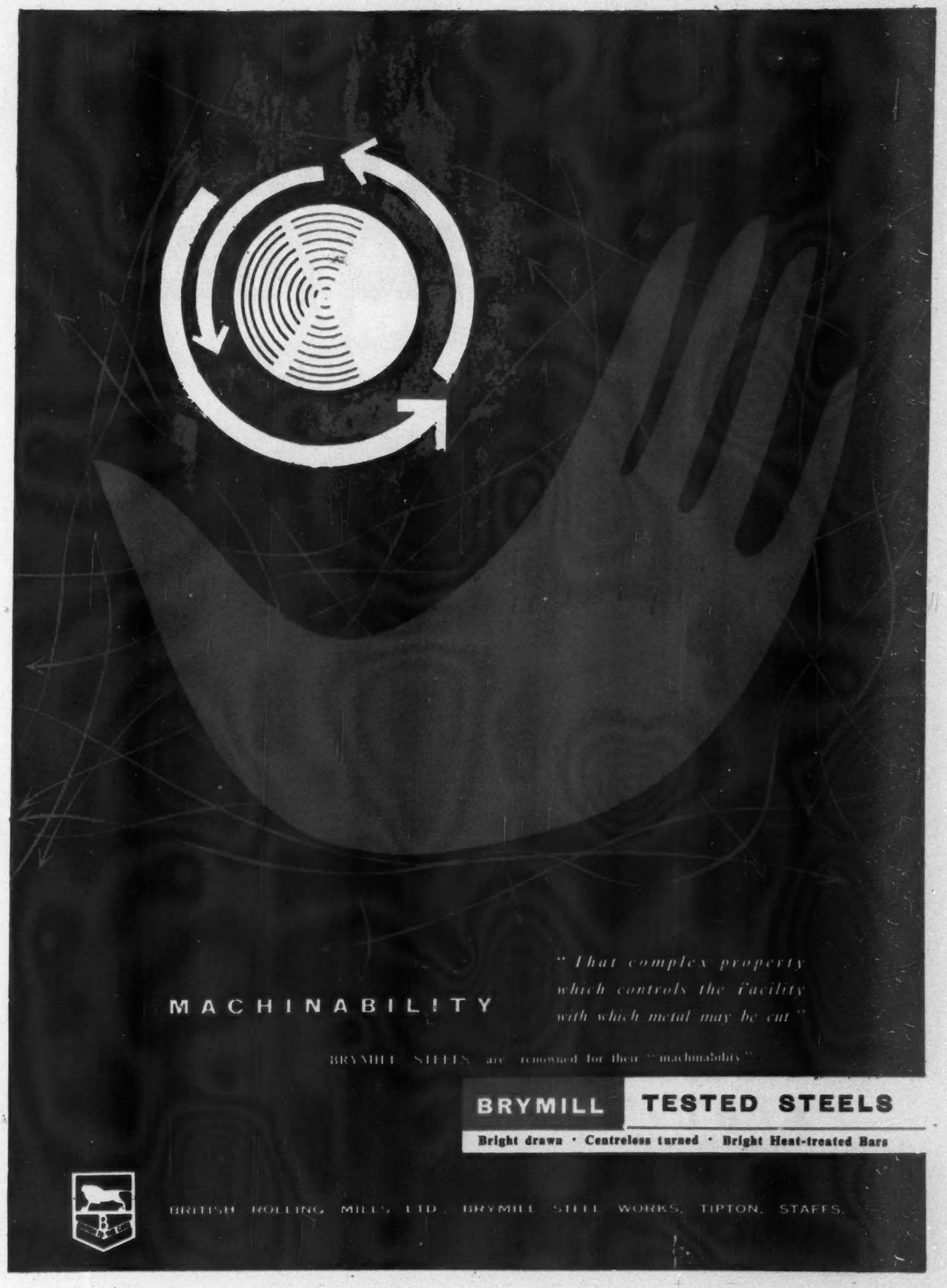
NAME.....

POSITION.....

COMPANY.....

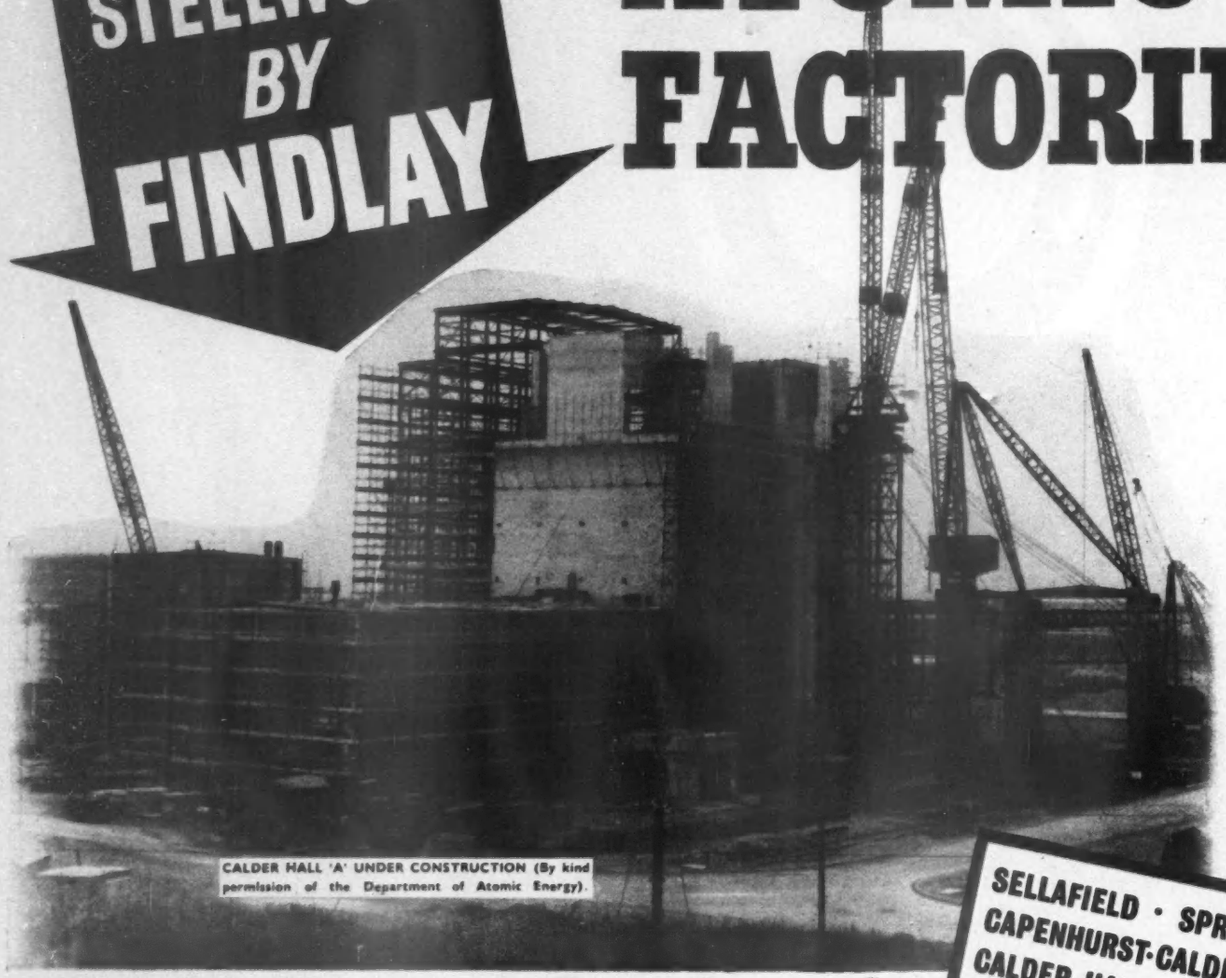
ADDRESS.....

CITY..... COUNTRY.....


MACHINABILITY
" That complex property which controls the facility with which metal may be cut "
BRYMILL STEELS are renowned for their "machinability"
BRYMILL TESTED STEELS
Bright drawn · Centreless turned · Bright Heat-treated Bars
BRITISH ROLLING MILLS LTD. BRYMILL STEEL WORKS, TIPTON, STAFFS.

BRITAIN'S ATOMIC FACTORIES

STRUCTURAL STEELWORK BY FINDLAY



CALDER HALL 'A' UNDER CONSTRUCTION (By kind permission of the Department of Atomic Energy).

SELLAFIELD · SPRINGFIELDS
CAPENHURST · CALDER HALL 'A'
CALDER HALL 'B' · HARWELL
CHAPELCROSS · DOUNREAY

60,000 Tons of Steelwork

UNDER DIRECT CONTRACT WITH THE U.K.A.E.A. ALEX. FINDLAY & CO. LTD., MOTHERWELL, HAVE BEEN ENTRUSTED WITH THE SUPPLY, DELIVERY AND ERECTION OF 60,000 TONS OF STRUCTURAL STEELWORK TO BUILD BRITAIN'S NUCLEAR POWER PROJECTS.

ALEX. FINDLAY & CO. LTD.

STRUCTURAL ENGINEERS

MOTHERWELL · SCOTLAND

Phone Motherwell 2301 (6 lines)

✻ *MEMBER OF THE NUCLEAR POWER PLANT CO. LIMITED*

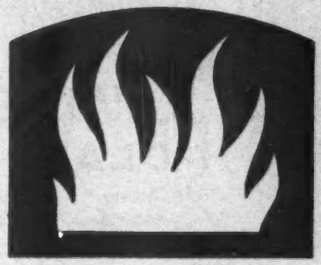
LONDON OFFICE: HIGH HOLBORN HOUSE, 52/54 HIGH HOLBORN W.C.1 TELEPHONE HOLBORN 7330-5083

WHITE CALCIUM-ALUMINATE CEMENT

(Over 70% Al_2O_3)

IRON COMPOUNDS & SILICA LESS THAN 1%

SECAR



250

Registered Trade Mark

Bonded with appropriate aggregates this cement provides Super-duty Castable Refractory Concrete for service temperatures up to 1,800°C (3,300°F) Refractory Concrete free from Iron Compounds & Silica is now possible for the first time.

A REFRACTORY CONCRETE FOR ANY PURPOSE

SECAR 250

is a product of

Lafarge Aluminous Cement Co. Ltd.

Manufacturers of

CIMENT FONDU

Regd Trade Mark

ALUMINOUS CEMENT

BECAUSE

Almost the entire Refractory field can be covered by Refractory Concretes based on SECAR 250 or CIMENT FONDU.
SECAR 250 concretes have all the well known properties of Ciment Fondu concretes

PLUS

- HIGH PURITY
- HIGH REFRACTORINESS
- HIGH SLAG RESISTANCE
- HIGH COLD STRENGTH
- HIGH SPALLING RESISTANCE
- HIGH CASTING ACCURACY
- HIGH RESISTANCE TO CORROSIVE ATMOSPHERES
- NO SPECIAL PRE-FIRING PROCEDURE

WRITE FOR BOOKLETS 'SECAR 250' AND 'REFRACTORY CONCRETE

LAFARGE ALUMINOUS CEMENT CO. LTD. 75, BROOK STREET, LONDON, W.1. TEL.: MAYfair 8548

AP/60

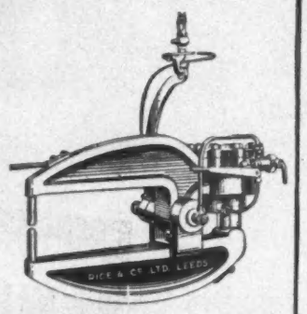
RICE-HYDRAULIC Machine Tools

RICE & Co (Leeds) Ltd., ELLAND ROAD, LEEDS 11 Telephone: LEEDS 75305

MAKERS OF

Pumps, Accumulators, Riveters, Presses for Flanging, Beading and Straightening, Deep Pressing, Lead Pipe Extrusion, Baling Steel Scrap, Wool, Cotton, etc.

London Office: 49, Queen Victoria St. E.C. Telephone CITy 7546



HYDRAULIC HINGED RIVETER
1'-6" to 3'-0" Gap. 20 to 30 tons power.

THE DELTA METAL CO., LIMITED

DELTA WORKS, EAST GREENWICH, LONDON, S.E.10 (and DELTA WORKS, DARTMOUTH STREET, BIRMINGHAM)

On the lists of the Admiralty, Air Ministry, War Office, India Office, Post Office, Crown Agents for the Colonies, Principal Railway and Steamship Companies, etc.

SOLE MANUFACTURERS OF "DELTA" BRAND Registered Trade Mark

HIGH-CLASS ENGINEERING ALLOYS:

Strongest Malleable Bronzes. Acid-proof and other Corrosion-Resisting Alloys. Ingots, Billets, Forgings, Stampings, Castings, Rods, Sheets, Wire Tubes, etc. "Delta" White Antifriction Metals, White Brass, Babbit Metal, etc. Manganese and Aluminium Bronze and Brass, Naval Brass, Yellow Metal, Copper, Zinc, Aluminium, etc.

Supplied to pass Admiralty Tests or other Specifications.

ORIGINAL AND LARGEST MANUFACTURERS OF

EXTRUDED METALS:

BRASS, BRONZE, YELLOW METAL, COPPER, NAVAL BRASS, RED METAL, etc.

STANWELD

OPEN STEEL FLOORING · STAIR TREADS & HAND-RAIL STANDARDS

- Every bar welded . . no rivets to work loose.
- Weight carrying with minimum depth and weight.
- Non-slip serrated tread.
- Any width or length.
- Spaced bars permit light and air circulation and also easy painting and cleaning.

With acknowledgements to the North Western Gas Board to whom we are indebted for the privilege of taking this photograph.

STANWELD ENGINEERING CO. LTD. Roundthorne Industrial Estate, Wythenshawe, Manchester 23
Tel: Wythenshawe 5555 (4 lines)

AGRICULTURE

AUTOMOTIVE INDUSTRIES · EARTH MOVING

MACHINE TOOLS · MECHANICAL HANDLING

MARINE ENGINEERING

GAS INDUSTRY

WHATEVER THE JOB

THERE'S A

DUNLOP

FLEXIBLE PIPE

TO CARRY IT THROUGH

Dunlop Technicians will always advise on any problems concerning installation of Flexible Pipes. Write please to :—

DUNLOP RUBBER COMPANY LIMITED · ST. GEORGE'S ROAD · COVENTRY · TELEPHONE: COVENTRY 84171

am/903

—when they're **TUFNOL**

Who likes noisy rollers? Not the people who run this factory. That's why the cast-iron rim of this 4 ton tobacco drying drum has roller wheels made of TUFNOL—a non-metallic material. For long-life TUFNOL gears and bearings—used throughout the plant — are smoother running — quieter running. More—they cut down wear on contact surfaces to a minimum.

TUFNOL roller wheels are used in a wide range of machinery, including cable stranding and rope making plants. You can machine gears, bearings—and other components—easily and accurately from TUFNOL sheets, tubes or rods. Or we can produce components to your specification. Ask for an engineer to call.

MAKE THE MOST OF TUFNOL
REGISTERED TRADE MARK
An ELLISON Product

TUFNOL LTD • PERRY BARR • BIRMINGHAM • 22B

310

AWCO announce ANODAL

a new insulated wire for windings

AWCO E P ANODAL INSULATED WIRE is a continuously-anodised electrical purity aluminium wire manufactured at the Port Tennant works of the Aluminium Wire & Cable Co. Ltd.

ANODAL insulated wire is at present supplied in sizes within the 16-36 swg range at prices which permit appreciable reduction in wire costs for many applications.

When used for windings, ANODAL insulated wire has unique properties that distinguish it from other insulated wires. They include:—

1. very high thermal stability of the insulation — coils have operated successfully at temperatures up to 550°C,
2. excellent heat transfer characteristics thus permitting lower and more uniform operating temperatures to be maintained throughout a winding,
3. appreciable reduction in weight for coils maintaining the electrical characteristics of a copper winding, and
4. smaller space occupied by the insulating film.

AWCO

ALUMINIUM WIRE & CABLE CO. LTD

Britain's Largest Manufacturers of Aluminium Wire and Conductors
Head Office and Works: PORT TENNANT, SWANSEA, GLAMORGAN
Sales Office: 2 ST. JAMES'S SQUARE, LONDON, S.W.1 Telephone: TRAfalgar 6441

Full particulars are available on request.

ANODAL is a registered trade mark.

APG5

COOPER Nuts and Bolts

Cooper nuts, bolts and studs are made to any specification, as regards material and dimensions.

Large stocks are carried for quick delivery.

ANOTHER ASPECT OF TWW SERVICE

GEORGE COOPER & SONS

PROPRIETORS THOS. W. WARD LTD.

EFFINGHAM NUT & BOLT WORKS

PHONE: 41026 SHEFFIELD GRAMS: "COOPER"

C/6

...as sound as a Gloucester casting!

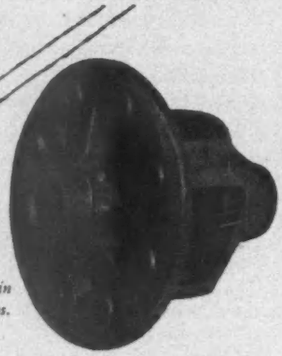
"As sound as a Gloucester Malleable casting" is no mere phrase. It is the result of a wealth of traditional skill and technical knowledge at every stage of production. Raw materials, melting and pouring processes, sand practice, moulding and core making, fettling and setting, all are exactly controlled to ensure castings that will measure up to to-day's exact engineering needs.

They are also accurately set under modern presses, using dies made to the limits required, to ensure that castings can be machined without costly delays.

Always consult Gloucester at the designing stage — even before.

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation	18%	Elongation	5%
Yield Point	12 tons	Yield Point	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi



Differential Cage in Malleable Iron. Weight 8¼ lbs.

Vehicle Steering Box in Malleable Iron. Weight 6¾ lbs.

GLOUCESTER THE HOME OF GOOD CASTINGS

GLOUCESTER

Gloucester Foundry Ltd., Emlyn Works, Gloucester · Telephone: Gloucester 23041 · Telegrams: 'Pulleys' Gloucester

(A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)

RAYNER POWER DRIVES

Infinitely Variable
3 H.P. Varigear 18 to 94 r.p.m.

Infinitely Variable
½ H.P.
400 to 2,000 r.p.m.

Infinitely Variable
¼ H.P.
10 to 50 r.p.m.

Compact purpose-made power drives are our business

PETER RAYNER LTD
121 WHITEHALL RD · LEEDS 12 *Telephone: LEEDS 33864*

RAYNER

WIND ALARM ANEMOMETER

GIVES A **WARNING** OF WIND SPEEDS

FOR USE ON **CRANES, TRANSPORTERS, DOCKSIDE STRUCTURES, BRIDGES & AIRPORTS.**

Enquire for details —

R. W. MUNRO LTD.
BOUNDS GREEN, LONDON, N.11.
Telephone: ENTERPRISE 4422

For your whole family!

Unique in the U.K. For the **first time** you can insure **YOURSELF · YOUR WIFE · YOUR CHILDREN · YOUR CHILDREN TO BE** and provide special protection against your disability, your accidental death or injury.

All this—and more besides—is offered at modest cost

in one policy

Every family man should write to-day for details of

the family policy . . . ***now offered for the first time by***

Confederation Life ASSOCIATION

(Incorporated in Canada in 1871, as a Limited Company.) *Assets over* £120,000,000

J. H. B. Clover, Manager of U.K. Branches,
CONFEDERATION LIFE ASSOCIATION
18 Park Lane, London, W.1.

Please send, without obligation, details of
THE FAMILY POLICY

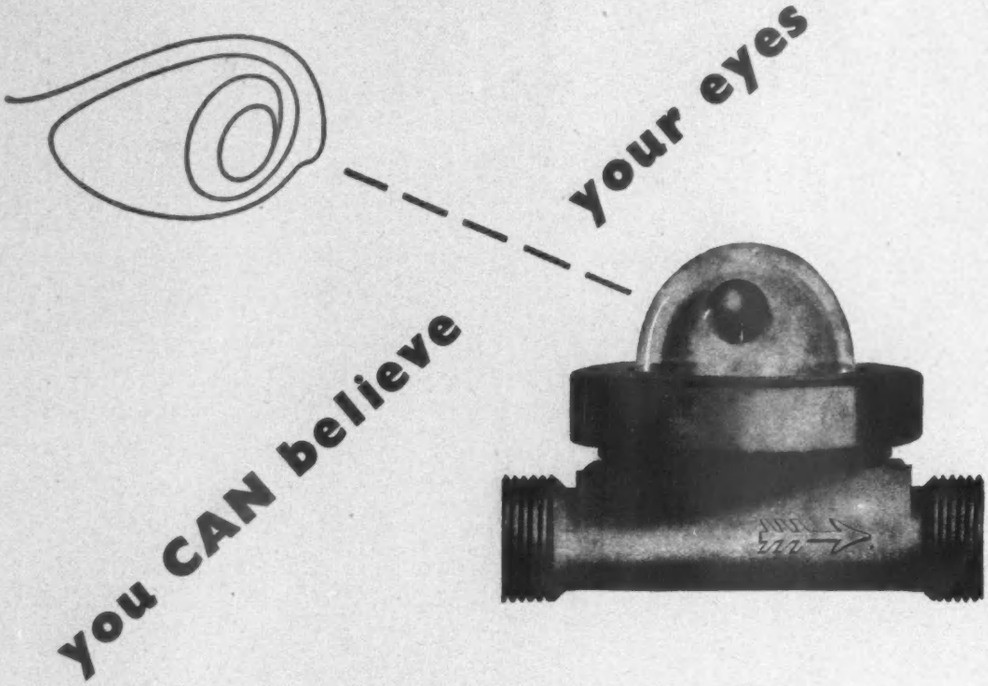
Name .....
Address .....
.....
Dates of Birth:
Father..... Mother..... E.8

Jobs like this . . . Putting together tank transporters is one of the bigger assemblies undertaken by Sankey of Wellington. At the other extreme, they produce washing machines by the thousand. In between; railway equipment, agricultural implements, steel furniture — anything, in fact, that calls for assembly operations on a big scale, whether in size, quantity or both. Sankey of Wellington are specialists in the shaping to close tolerances of metals in sheet, strip or plate. They are the largest producers of vehicle wheels in Europe, and their chassis frames, panels and similar components are found on British road vehicles throughout the world. In matters of pressing, welding, precision machining and large-scale assembly work of all kinds they are *the* experts. And the bigger the job the better they like it.

are best done by...

Sankey OF WELLINGTON

JOSEPH SANKEY & SONS LIMITED, HADLEY CASTLE WORKS, WELLINGTON, SHROPSHIRE. PHONE: 4321 WELLINGTON, SHROPSHIRE · GRAMS: SANKEY, WELLINGTON, SHROPSHIRE.

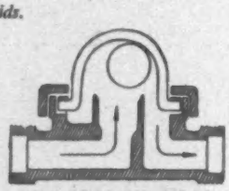


You don't need second sight when a 'SHOFLO' is in the line.

Where circulating water systems are concerned, for radiators, condensers, liquid vats, oil coolers, radio transmitting equipment and the like, a 'SHOFLO' Indicator is the perfect answer when you've got to tell *at first sight* whether the coolant is flowing or not.

LOW FLOW

A whirling ball under the toughened glass dome indicates passage of clear or translucent liquids at flows as low as 4 g.p.h., pressures up to 100 p.s.i. Standard casing is aluminium bronze for ½" sizes, gunmetal for 1½" sizes; other metals for alkaline or acidic fluids.



HIGH FLOW

Available in two sizes: Nominal ½" and 1½" bores for flows up to 2,000 g.p.h. ½" size also made with right angle inlet and outlet.

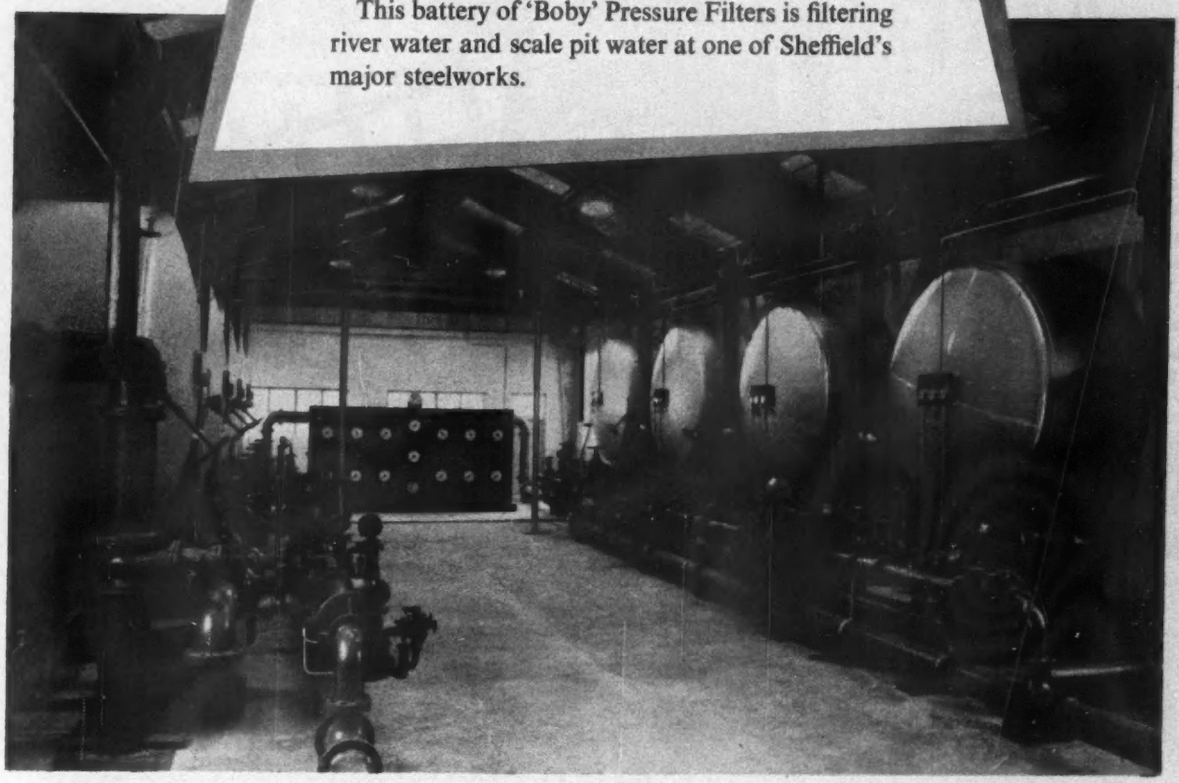
SHOFLO

tells at a glance

MEASUREMENT LTD., Tameside Works, Dobcross, Near Oldham. Tel.: Delph 424 (5 lines)
EXPORT ENQUIRIES to: Parkinson Cowan Group Exports Ltd.
Terminal House, Grosvenor Gardens, London, S.W.1.
Telephone: SLOANE 0111/4 Cables: DISC, London
A Parkinson Cowan Company

'Boby' Pressure Filters

This battery of 'Boby' Pressure Filters is filtering river water and scale pit water at one of Sheffield's major steelworks.



A notable feature of this 'Boby' Filtration Plant is that the extremely dirty River Don water is filtered successfully without any form of pretreatment.

The filtered water is used for fabric bearing cooling, strip mill cooling sprays, and general steelworks services.

If you have a feed-water treatment problem please write to:

WILLIAM BOBY
& COMPANY, LIMITED
RICKMANSWORTH, HERTFORDSHIRE
ENGLAND

Telephone: Rickmansworth 4251*

WATER
BOBY
TREATMENT

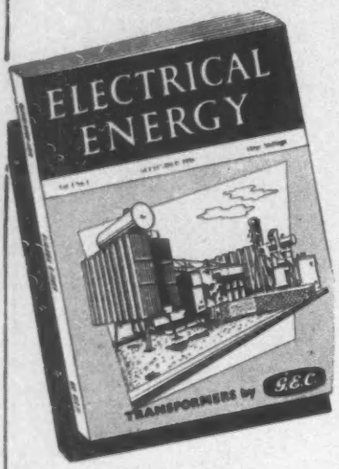
Established in 1875

Exploit Electrical Progress!

ELECTRICAL ENERGY offers a distinctive service to its readers.

It is a monthly journal designed to provide them with a steady flow of accurate and up-to-date information exclusively about those matters which concern them as electrical engineers.

Its purpose is to pass on to its readers the knowledge gained by others in the course of their work.



The following is a representative selection of titles:—

System Generated Overvoltages (2 Parts).

Electrical Insulation (2 Parts).

A Symmetrical Component Voltage and Current Analyser.

Impulse Voltage Strength of Oil Immersed Insulation.

Permanent Magnets (2 Parts).

Automatic Power Plant for Telecommunication Equipment.

Control and Instrumentation in a Nuclear Power Station.

Survey of the Methods Available for Analysis and Synthesis of Non-Linear Servomechanisms (2 Parts).

D.C. Winder Control Using Mercury Arc Rectifiers.

In addition there are regular features, which include Book Reviews and descriptions of New Electrical Equipment.

Annual Subscription : £1 16s. 0d.
Single Copies : 3s. 0d.

Order through your newsagent or direct from:—

ELECTRICAL ENERGY

28 ESSEX STREET, STRAND, W.C.2
PUBLISHED MONTHLY BY
MORGAN BROTHERS (Publishers) Ltd.
Proprietors of "The Engineer" and "Electronic Engineering"

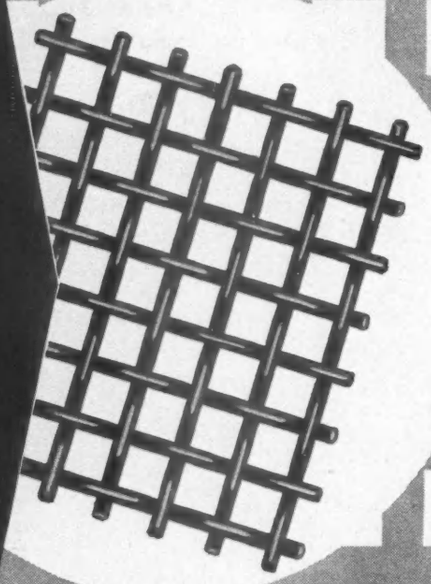
WOVEN WIRE SCREENS

ACCURATE AND CONSTANT MESH

IN ALL STRENGTHS

IN ANY COMMERCIAL METAL

FOR ALL PURPOSES



Please ask for Catalogue W28

Greenings
H. GREENING AND SONS LTD.
BRITANNIA WORKS
WARRINGTON · ENGLAND
P.O. BOX 22

ESTABLISHED 1799
Telephone WARRINGTON 32401
Telegrams GREENINGS WARRINGTON

NG 53

IRONSIDES *Specialists in Roll Neck & Gear Lubrication*

THE IRONSIDES LUBRICANTS LTD · DAW BANK · STOCKPORT · Telephone: Stockport 2419

EVERYTHING FOR THE PATTERN SHOP

MALL IRON DOWEL PLATES DOWELS FOR METAL PATTERNS

FILLETS
"PLASTIFIL" "POLYFIL"
LEATHER FILLET

LETTERS
ALL SIZES AND STYLES

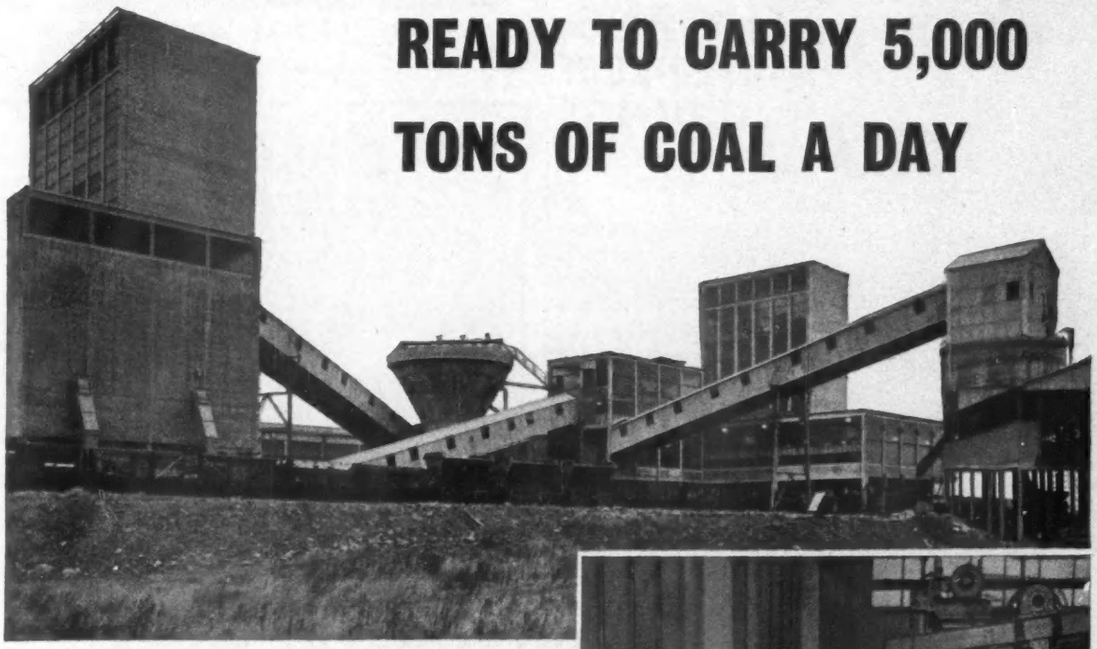
B

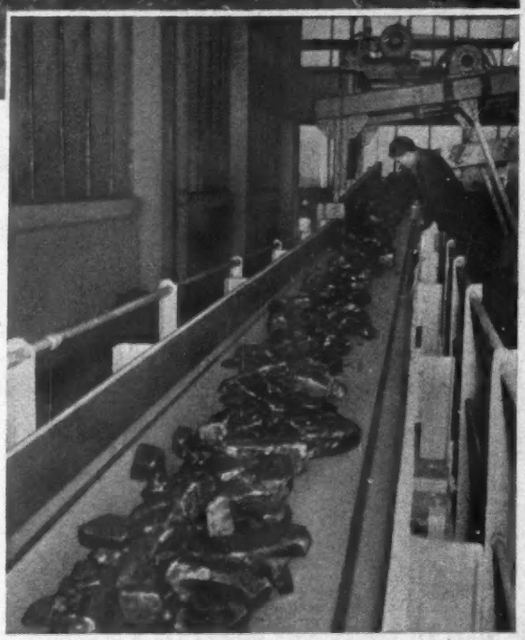
BRASS DOWELS AND SOCKETS

J.W. & C.J. PHILLIPS LTD.,
POMEROY ST., NEW CROSS, LONDON, S.E.14

US RUBBER GIANT CONVEYOR BELTING

READY TO CARRY 5,000 TONS OF COAL A DAY





Specified for the vitally important Rothes Colliery project

Rothes Colliery, now almost completed, will be one of Scotland's largest coal-producing units. The normal output is expected to be 500 tons per hour—5,000 tons a day!

U.S. Giant Conveyor Belting plays a vital part in this great project—as it does in collieries all over Britain. Why? Because U.S. Giant incorporates maximum flexibility, wide range of tensile strengths to suit particular drives, maximum adhesion, high quality rubber, mildew-resistant duck.

U.S. Giant is the result of years of constant research, and offers the greatest resistance to abrasion, tearing and gouging. It is being used all over the world, conveying gold ore, quartz, iron, copper, sand, gravel and coal.

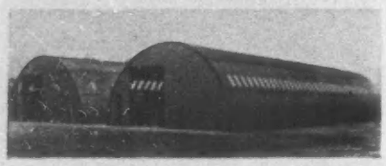
Photographs by courtesy of the National Coal Board

U. S. Rubber

Home: *The North British Rubber Company Limited. ABBey 7135*
Export: *U.S. Rubber International (Great Britain) Ltd. ABBey 2053*

62/64 HORSEFERRY ROAD, LONDON, S.W.1

MORE SPACE - LESS COST



Minimum cost, adaptability, ease of erection—the characteristics of curved-roof construction.

THORNS CURVED-ROOF BUILDINGS

can be delivered and erected quickly in any part of the country.

The accompanying examples show Blister hangars, Romney huts and Nissen-type huts. These are constructed in multiple lengths, and are available in basic widths of 16ft., 24ft., 30ft., 35ft. & 91ft.

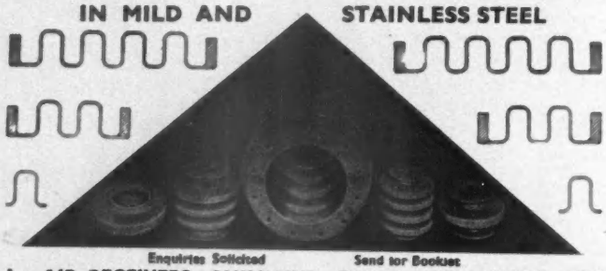
Get a quotation from THORNS, or write for fully-illustrated leaflet.

THORNS

J. THORN & SONS LTD. (Dept. 81)
BRAMPTON ROAD · BEXLEYHEATH · KENT
BD 266

ROSE'S EXPANSION PIECES

PRESSED STEEL BELLOWS TYPE
IN MILD AND STAINLESS STEEL



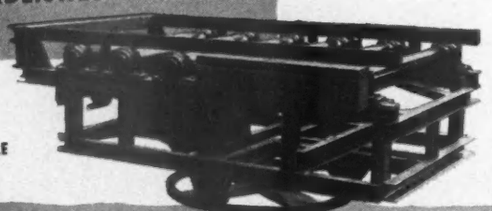
Enquiries Solicited Send for Booklet

also AIR RECEIVERS, CHIMNEYS, TANKS, PIPE WORK, PRESSURE CYLINDERS, AND FABRICATED STEEL PLATEWORK

BRITISH APPLIANCES MFG. CO., LTD.
DOLLY LANE, LEEDS, 9
Telephone : 30725-6 Telegrams : STRUCTURAL LEEDS 9

ROBSON CONVEYORS

ESTABLISHED 1906



10 TON ROLLER TURNTABLE

Geo. ROBSON & CO. (CONVEYORS) LTD.
HODGSON STREET · SHEFFIELD.
PHONE. SHEFFIELD. 27463/4

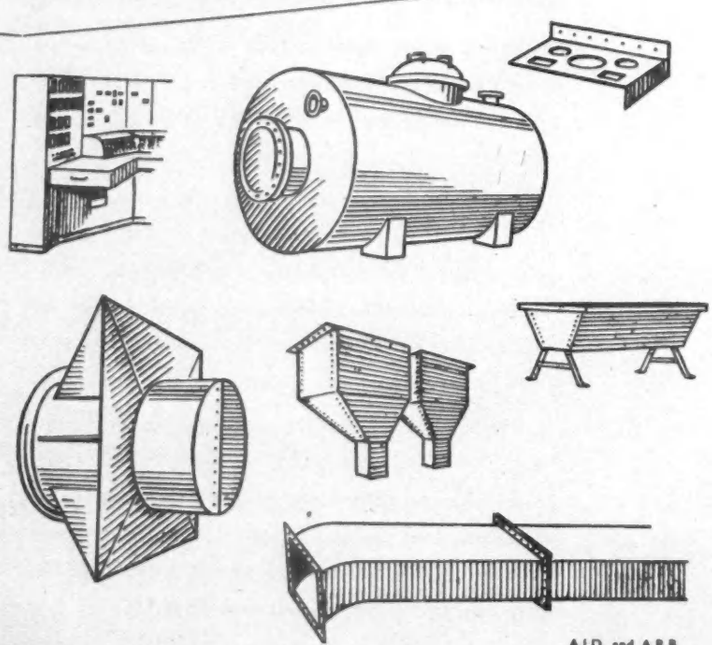
EVERYTHING IN SHEET METAL WORK GENERAL ENGINEERING

Consult

V. W. CO., LTD.

FOR FABRICATION and GENERAL ENGINEERING

General Sheet Metal Work, Metal Pressing and Stamping, Duct Work and Ventilating Plants, Tanks Cylinders Turning Milling etc. PLATING, Chrome, Nickel, Cadmium etc.



A.I.D. and A.R.B. approved

V. W. CO., LTD.

Radspray Works, High Street, Stratford, London, E.15 *Tel: MARyland 6761 (6 lines)*
Also at: EASTERN INDUSTRIAL ESTATE, HARLOW, ESSEX *Tel: 24721*

Chemical Plant

in copper and stainless steel

Distillation columns, solvent recovery plant, autoclaves, expansion joints and many other specialised process-plant items — Dore have the experience and the skill to manufacture welded plant of the highest standard, for delivery at the right time, at the right price.

JOHN DORE & CO. LTD.

31-39 Bromley High Street, Bromley-by-Bow, London, E.3. 'Phone: ADVance 3421

GET A Keen QUOTATION FROM . . . . .

JOHN DORE & CO LTD

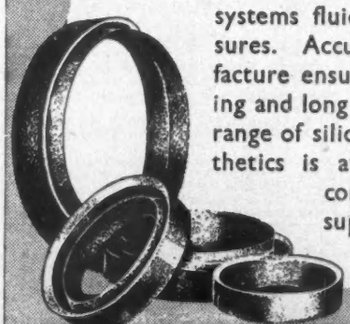
TAS/JD.7B

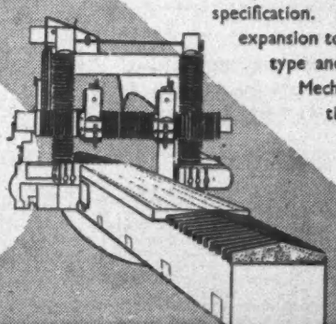
Fortox

INDUSTRIAL LEATHERS MANUFACTURED TO SPECIFICATION

HYDRAULIC LEATHERS AND PACKINGS

are manufactured for all types of systems fluids and pressures. Accuracy of manufacture ensures positive sealing and long trouble free life. A range of silicone leathers and synthetics is available for extreme conditions. Single items supplied promptly.





FORTOX FLEXIBLE BELLOWS *protect machinery and exclude dirt.*

All shapes and sizes manufactured exactly to your specification. New type of construction gives an expansion to contraction ratio of 10-1. Prototype and development work a speciality. Mechanical leathers of all descriptions. Write today for enquiry forms and full details of our work.

HENRY BEAKBANE (FORTOX) LIMITED

HEAD OFFICE AND TANNERY
THE TANNERY · STOURPORT ON SEVERN · WORCS.
TELEPHONE · STOURPORT 2077

LONDON WORKS
68 - 70 LANT STREET BOROUGH S. E. 1.
TELEPHONE · HOP 0456

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

UNIVERSITY OF SYDNEY

AUSTRALIA

LECTURESHIP/SENIOR LECTURESHIP IN AERONAUTICAL ENGINEERING

Applications are invited for the above-mentioned position. The successful applicant will be expected to lecture in the subject of Aircraft Structures. Some experience in the field of Aeroelasticity is desirable, but not essential.

The salary for a Lecturer will be in the range £A1500–£A90–£A2100 per annum, for a Senior Lecturer in the range £A2200–£A80–£A2550 per annum. In each case cost-of-living adjustment will be allowed. The salary will be subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

The closing date for the receipt of applications, in Australia and London, is 9th August, 1958. E7915

COLLEGE OF AERONAUTICS

SENIOR LECTURER

Applications are invited for the appointment of SENIOR LECTURER IN MECHANICAL ENGINEERING as applied to AERO-PROPULSION SYSTEMS. The successful candidate will be required to lecture on: the relationship of performance parameters to mechanical and constructional parameters; engine stressing; vibration; gearing; and bearings. The duties will also include supervision of staff and student research in these fields and direction of student project studies. Candidates should have extensive aero-engine research and design experience, preferably industrial, with particular experience in one or more of the aspects referred to above. Suitable academic and professional qualifications essential. Salary in scale £1700 by £75 to £2150 p.a., depending on qualifications and experience, with superannuation under F.S.S.U., and family allowance. Applications giving full particulars and quoting the names of three referees, to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks., from whom further particulars may be obtained. E7924

CITY OF WAKEFIELD EDUCATION COMMITTEE

TECHNICAL AND ART COLLEGE

ASSISTANT GRADE A

ASSISTANT GRADE A required for Electrical Engineering and related subjects, to Ordinary National Certificate Standard. Applicants should possess suitable qualifications (e.g. H.N.C.) and have industrial experience.

Form of application and further particulars relating to the appointment may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope.

C. L. BERRY,
Director of Education.

Education Department,
27, King Street,
Wakefield. E7929

QUEEN'S UNIVERSITY OF BELFAST

LECTURESHIP IN MECHANICAL ENGINEERING

The Senate of the Queen's University of Belfast invites applications for a LECTURESHIP IN MECHANICAL ENGINEERING from 1st January, 1959. Salary range £1300 to £1650, plus contributory pension rights under the F.S.S.U. Initial placing at any point on the salary scale will depend on qualifications and experience. Applications should be received by 30th August, 1958.—Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary. E7911

PUBLIC APPOINTMENTS

CITY OF LIVERPOOL EDUCATION COMMITTEE

CITY COLLEGE OF TECHNOLOGY,
BYROM STREET, LIVERPOOL, 3.

Principal: S. A. J. PARSONS, B.Sc. (Econ.), M.I.Mech.E., M.I.Prod.E., M.B.I.M.

DEPARTMENT OF CIVIL, MECHANICAL AND MARINE ENGINEERING

HEAD OF THE DEPARTMENT

Applications are invited for the appointment of HEAD OF THE DEPARTMENT OF CIVIL, MECHANICAL AND MARINE ENGINEERING, duties to commence 1st January, 1959. Salary: £1750 by £50 to £1900 per annum (Burnham Scale, Grade IV). The Department contains a Production Engineering Section (including Sheet Metal Work and Welding) and Metallurgy. The work generally is of an advanced nature and includes sandwich courses.

Applicants should possess high academic qualifications; industrial and teaching experience to Degree level is essential; research experience is desirable, and applicants must possess organising and administrative ability.

The person appointed will be expected to develop the work of the department with particular reference to the provision of post-graduate courses and research.

Further particulars and application form (returnable by 25th July, 1958) may be obtained from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
Town Clerk and Clerk to the
(J.5254.) Local Education Authority. E7965

UNIVERSITY OF LIVERPOOL

MECHANICAL OR CHEMICAL ENGINEER

An experienced MECHANICAL or CHEMICAL ENGINEER is required for a post with a team working in the University of Liverpool on the Joint Universities Liquid Hydrogen Bubble Chamber. This is a device for recording the tracks of atomic particles of high energy and will be used in conjunction with the big particle accelerating machines to be built at Cern, Geneva, and at the Rutherford Laboratory at Harwell. It is a large-scale project involving intricate engineering at a very low temperature.

The post is intended for an engineer to take considerable responsibility in design, construction and operation of the bubble chamber. The appointment will be for a period of three years, starting at a date to be agreed, preferably before 1st October, 1958, and there will be a possibility of extension. Salary will be in accordance with age and experience.—Applications in writing to the Registrar, The University, Liverpool, 3. E7918

COUNCIL FOR TECHNICAL CO-OPERATION IN SOUTH AND SOUTH-EAST ASIA

APPOINTMENTS

Applications are invited by the Commonwealth Relations Office for two appointments under the Technical Co-operation Scheme of the Colombo Plan, at the University of Ceylon, as follows:

1. PROFESSOR OF MECHANICAL ENGINEERING
2. LECTURER IN ELECTRICAL ENGINEERING (ELECTRIC POWER).

Candidates for both posts must have several years' research and University teaching experience. Duration 3 years in the case of the Professor of Mechanical Engineering and 2 to 3 years in the case of the other post. Salary for (1) £2300 p.a. plus tax-free overseas allowance of £1090 p.a. (married) or £590 p.a. (single) and for (2) £1650 p.a. plus tax-free overseas allowance of £1090 p.a. (married) or £590 p.a. (single), plus other allowances. Free furnished accommodation provided. Contract with the U.K. Government. For further information and application forms write Ministry of Labour and National Service (E.9), 26–28, King Street, London, S.W.1, quoting E.9/TCS/216-7/CEY. E7923

PUBLIC APPOINTMENTS

NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING OF UNIVERSITY COLLEGE, IBADAN, AT NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY

APPOINTMENTS

Applications are invited for the following appointments:—

(1) HEADSHIPS of the DEPARTMENTS OF CIVIL ENGINEERING, MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING.

(2) SENIOR LECTURESHIPS or LECTURESHIPS in CIVIL ENGINEERING, MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING.

Contract salary: Including inducement addition to overseas candidates.

(1) Within the scales, Grade A, £2664 by £72 to £2880 per annum, or Grade B, £2448 by £72 to £2664 per annum.

(2) Senior Lectureship: Grade I, £2160 by £72 to £2376 per annum; Grade II, £1668 to £2028 per annum.

Lectureship: £1290 to £1968 per annum.

Non-contributory pension scheme. Pensionable appointments at appropriately lower salaries could be arranged if successful applicants so desire. Children's U.K. maintenance and other allowances. Passages paid for appointees and families (up to four adult passages) on appointment, annual leave and normal termination. Part-furnished houses at moderate rent.

A scheme has been approved associating the Faculty of Engineering with University College, Ibadan, and thus bringing the Faculty into the scheme of Special Relation with the University of London.

Detailed applications (6 copies), naming 3 referees, by 15th August, 1958, to Secretary, Inter-University Council for Higher Education Overseas, 29, Woburn Square, London, W.C.1, from whom further particulars may be obtained. E7967

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL COLLEGE,
FARNBOROUGH, HANTS

LECTURERS

Applications are invited for the following vacancies in the above selective Day College:

Post 1: LECTURER in AIRCRAFT STRUCTURES.

Post 2: LECTURER in MECHANICAL ENGINEERING

University degree or equivalent, and preferably some industrial and/or teaching experience.

Candidates for Post 1 should be capable of accepting responsibility for teaching the subject for final B.Sc. (Eng.), Diploma in Technology, A.F.R.Ae.S., and H.N.C. For Post 2 ability to teach general Mechanical Engineering to the standards specified in Post 1 required and ability to teach Engineering Design an advantage. Candiate for either post may be invited to act as O/C College Experimental Flight Testing Training with a special additional allowance.

Facilities for further study and/or research may be available. Successful candidates should start as soon as possible.

Burnham Scale for Technical Colleges (subject to Teachers' Superannuation Acts) £1200 by £30 to £1350; commencing salary in accordance with experience.

Application Forms from Principal of College for return within 14 days. E7936

QUEEN MARY COLLEGE
(UNIVERSITY OF LONDON),
MILE END ROAD, E.1

LECTURER

Applications are invited for the post of LECTURER IN MECHANICAL ENGINEERING. Salary scale: £900 by £50 to £1350 (efficiency bar); £1425 by £75 to £1650, plus London Allowance £60 (initial salary according to qualifications and experience), with F.S.S.U. participation and family allowance of £50 for each child.

Application forms obtainable from the Registrar. E7945

PUBLIC APPOINTMENTS

WEST MIDLANDS GAS BOARD

BIRMINGHAM AND DISTRICT DIVISION

ASSISTANT MECHANICAL ENGINEER

BIRMINGHAM DISTRICT

Candidates should have served an apprenticeship in engineering and have had further experience in general engineering and steam plant. Possession of an Engineering Degree, Membership of the Institution of Mechanical Engineers or a Higher National Certificate is essential. Some knowledge of mechanical handling plant and/or experience on Work Study as applied to maintenance work would be an advantage.

The person appointed will be required to assist in the maintenance work on Gas Works plant and the installation of new plants.

The salary will be in accordance with Grade APT 12 (£945–£1070 per annum) of the National Salary Scales for Gas Staffs.

The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications, stating age, training, qualifications and experience, together with the names of two referees, should be sent to Mr. J. E. Wakeford, Divisional General Manager, West Midlands Gas Board, Gas Offices, Edmund Street, Birmingham, 3, to reach him not later than the 18th July, 1958.

J. SWAN,
E7930 Secretary to the Board.

FEDERATION OF MALAYA

MECHANICAL ENGINEERS

MECHANICAL ENGINEERS and INSPECTORS OF MACHINERY are required for the Public Works, Drainage and Irrigation, Railway and Machinery Departments on 3 years' contract in the first instance.

QUALIFICATIONS: A.M.I.Mech.E. or its equivalent, plus approved practical experience.

AGE: 25–35 preferred.

BASIC SALARY: From $628, rising to $1254 p.m. (£879 to £1755 per annum). Commencing salary according to experience. In addition, Expatriation and Cost of Living Allowances, substantial gratuity, full pay vacation leave, free passages, free medical attention (except for a small charge for maintenance in hospital).

Further details and application forms can be obtained from the Recruitment and Personnel Division, Dept. E., Malaya House, 57, Trafalgar Square, London, W.C.2. E7949

THE REPUBLIC OF THE SUDAN

DEPARTMENT OF POSTS AND TELEGRAPHS

APPOINTMENTS

The Department of Posts and Telegraphs of the Ministry of Communications invites applications from those suitably qualified to fill the following vacancies:

(a) TELEPHONE ENGINEER (4/1705).
(b) TRANSMISSION AND LINES ENGINEER (4/1703).
(c) RADIO ENGINEER (4/1701).
(d) ASSISTANT BROADCASTING ENGINEER (4/1709).

Candidates must have had at least 10 years' practical experience in the relevant branch of telecommunication engineering and be fully literate in either Arabic or English.

The appointment will be on contract for a period of three years with or without bonus in the salary scales as follows:

For posts (a), (b) and (c), £S1075 to £S1675 with bonus, or £S1146 to £S1786 without bonus.

Post (d) £S800 to £S1350 with bonus, or £S853 to £S1440 without bonus.

Starting pay will be fixed according to age, qualifications and experience. A Cost of Living Allowance, which is reviewed every two months, is payable, and an Initial Outfit Grant of £S50 on appointment. Leave with free air passage accrues at the rate of 7 days per month.

Applications should, in the first instance, be in writing enclosing two copies of recent testimonials and sent to Sudan Embassy, Personnel Section, Cleveland Row, St. James's, S.W.1, quoting reference as above. E7937

PUBLIC APPOINTMENTS

AUSTRALIA

STATE ELECTRICITY COMMISSION OF VICTORIA

CHEMICAL STAFF

The State Electricity Commission of Victoria seeks applications from INDUSTRIAL CHEMISTS of A.R.I.C. standard, with appropriate experience, for appointment to the staff of its high pressure steam power stations.

The Commission is constituted as a semi-government authority by Act of Parliament and is one of the largest electricity supply authorities in the Commonwealth of Australia, and is the largest producer of fuel with brown coal and briquette enterprises in the Latrobe Valley. It has a capital investment of approximately £A250 million, with an annual revenue of £A36 million.

The major steam stations are situated in the Latrobe Valley approximately 90 miles east of Melbourne, and the rapid expansion of the Commission's system involves the construction in this area of additional steam power plants of up to 1000MW capacity burning pulverised brown coal.

Facilities in this rapidly developing area include excellent schooling, shopping and sporting facilities, subsidised medical and hospital services and the other modern amenities of urban areas.

Salaries for the different grades appropriate to the applicant's qualifications and experience are :

Chemist, Grade I, up to £A1586
Chemist, Grade II, from £A1638 to £A1742
Chemist, Grade III, from £A1795 to £A1899

These salaries include cost of living adjustment of £A490 per annum

Applicants for Grades 2 and 3 must have had experience of power station chemistry in high pressure steam plants or in research organisations working on problems associated with the operation of such plants.

Appointees and their families can be nominated and transported to Australia under the Commonwealth Government's Migration Scheme, details of which can be obtained from officials at Australia House, The Strand, London. Suitable housing for rental will be made available immediately to married appointees, and good hostel accommodation at a reasonable tariff will be available for single appointees.

Married appointees will be reimbursed at the expiration of six months' satisfactory service an amount of up to £A150, upon production of necessary receipts, in respect of removal of household furniture and effects.

Further details may be obtained on application to the Staff Superintendent at the address mentioned below.

Arrangements will be made for representatives of the Commission to interview selected applicants in England.

Applications, giving full details of qualifications, experience and war service (if any), stating date of birth and accompanied by copies of testimonials, should be submitted not later than 23rd August, 1958, to the Secretary—

STATE ELECTRICITY COMMISSION OF VICTORIA
22–32, William Street, Melbourne, C.1,
Victoria, Australia. E7925

HERTFORD GROUP HOSPITAL MANAGEMENT COMMITTEE

SENIOR ENGINEER

SENIOR ENGINEER required for the Hertford Sub-Group of Hospitals. Preference given to candidates holding a First Class Certificate of Competency in Marine Engineering (or equivalent Naval Certificate) or City and Guilds Full Technological Certificate in Plant Engineering (First Class).

Applicants should have completed an apprenticeship in Mechanical Engineering, or have acquired a thorough practical, mechanical engineering training. They must have a sound knowledge of efficient operation of steam boiler plants and wide experience in a supervisory position of mechanical and electrical engineering services as found in Institutions.

The person appointed will be responsible to the Superintendent Engineer and will be required to assist in supervision of general building and maintenance work.

Salary scale £655 by £25 (5) to £780. The post is superannuable. The successful applicant will be required to live at, or reasonably close to, Hertford. No accommodation provided.

Applications stating age, qualifications, experience, with names of two referees, to Group Secretary, Hertford County Hospital, Hertford, Herts, by 9th August, 1958. E7897

GOVERNMENT OF WESTERN NIGERIA

MINISTRY OF WORKS AND TRANSPORT

MECHANICAL ENGINEER

To assume responsibility for the proper operation, maintenance and overhaul of road vehicles, heavy earth-moving equipment and all types of building, water works and civil engineering construction plant in an executive capacity, either in charge of one or more workshops or when required in administrative duties in Area or Regional Headquarters. Duties will include touring and involve technical reports and advice on installations, specification for indenting and contracting, and control of expenditure.

Contract appointment. Salary range : £1848 to £2082 per annum. Gratuity of £37 10s. for each completed three months' service, payable on satisfactory completion of contract. Free passages for officer and wife, and cost of passages for children under 18 to a maximum of £450. Quarters, if available, at low rent. Free medical attendance.

Candidates, between 30 and 50, must be A.M.I. Mech.E. and have had at least 8 years' post qualification experience and been in control of staff. Knowledge of cost analysis, stores indenting, simple accounting and works organisation necessary.

Write, Director of Recruitment, Colonial Office, London, S.W.1, stating, briefly, age, qualifications and experience, quoting BCD 112/410/023. E7961

PUBLIC APPOINTMENTS

ILFORD AND BARKING GROUP HOSPITAL MANAGEMENT COMMITTEE

DAGENHAM HOSPITAL

ASSISTANT ENGINEER

ASSISTANT ENGINEER required—Non-resident—at the Dagenham Hospital, Rainham Road South, Dagenham (150 beds). Salary scale £555 to £675 plus London Weighting £30. Applicants must have completed an apprenticeship in mechanical engineering. They should hold either an ordinary National Certificate in mechanical engineering (which includes Heat and Heat Engines as a subject and preferably has an endorsement in the principles of electricity) or second class certificate of competency in Marine Engineering, and should have had experience in all types of steam raising boiler plant, sectional boilers, kitchen machinery, and general building maintenance.

The person appointed will be responsible to the Superintendent Engineer for the satisfactory operation of all maintenance and building works.

Applications, giving names of two referees should be sent to the undersigned.

H. F. HARRIS,
Group Secretary.

King George Hospital,
Ilford, Essex. E7940

AIR MINISTRY WORKS

DESIGN BRANCH

DESIGNER DRAUGHTSMEN

Air Ministry Works Design Branch requires in London DESIGNER DRAUGHTSMEN for BULK PETROLEUM STORAGE AND PUMPING INSTALLATIONS experienced in one or more of the following : (a) Storage tank layout and design ; (b) pump house and plant layout ; (c) development of pipe line schemes ; (d) hydraulic calculations. Technical training to O.N.C. standard required. Salaries up to £1015 p.a. Starting pay dependent on age, qualifications and experience. Long term possibilities with promotion and pensionable prospects. Five-day week, three weeks three days leave a year. Normally natural born British subjects.—Write, stating age, qualifications, employment details, including type of work done, to any Employment Exchange quoting Order No. Borough 105. E7233

SURREY COUNTY COUNCIL

ASSISTANT HEATING ENGINEER

Applications invited for appointment of ASSISTANT HEATING ENGINEER, Special Grade £750–£1030 p.a., plus £30 p.a. London allowance. Must be A.M.I.H. and V.E. and experienced in heating and ventilating installations. Preferably experienced in testing boiler efficiencies.

Full details, present salary and three copy testimonials, to County Architect, County Hall, Kingston, as soon as possible. E7921

PUBLIC APPOINTMENTS

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

(INDUSTRIAL GROUP)

is seeking

ENGINEERS,

CHEMICAL ENGINEERS,

or

PHYSICISTS

for training as

REACTOR TECHNOLOGISTS

Applicants should be at least 26 years of age and possess a good University degree, or be Corporate Members of a Senior Engineering Institution. Industrial experience is desirable, but not essential.

Successful candidates will be attached initially to the Industrial Group Headquarters at Risley, Lancashire, and will undergo a two-year period of training at various atomic energy establishments.

Ultimately they will be expected to take up appointments at reactor stations either in a managerial capacity on the plants or as members of the Works' Technical Teams.

The reactor stations concerned are at Calder Hall, Cumberland, and Chapelcross, Dumfriesshire.

Salaries assessed according to qualifications and experience in the scale £1300—£2080 p.a.

Contributory Pension Scheme.

Housing or assistance towards legal expenses on house purchase may be available.

Send postcard for application form, quoting reference 2476, to Recruitment Officer, U.K.A.E.A., I.G., H.Q., Risley, Warrington, Lancashire.

Closing Date : 28th July, 1958

E7910

STRUCTURAL ENGINEERING DRAUGHTSMEN

required by

MINISTRY OF WORKS

for employment in London, Scotland and Provinces on design and detailing of reinforced concrete or structural steelwork.

SALARY RANGE £550 (age 21) to £870 p.a., London (slightly less elsewhere).

5-DAY WEEK. 3½ WEEKS' ANNUAL LEAVE INITIALLY.

STARTING PAY ACCORDING TO AGE, QUALIFICATIONS AND EXPERIENCE.

GOOD PROSPECTS OF PROMOTION WITH SALARIES OF £1015 p.a. AND ABOVE.

OPPORTUNITIES FOR PERMANENT POSTS LEADING TO PENSIONS (NON-CONTRIBUTORY).

Possession of O.N.C. or equivalent an advantage.

Interviews at Regional Offices where possible.

APPLICATIONS.—State age, training and experience to Chief Structural Engineer, Ministry of Works, Room 404, Abell House, John Islip Street, S.W.1.

E7717

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

DEPARTMENT OF MECHANICAL CIVIL AND CHEMICAL ENGINEERING

MECHANICAL ENGINEERING DESIGN

Applications are invited for a Senior Lecturer in Mechanical Engineering Design. Applicants should have a good Honours degree and industrial experience. Previous teaching experience in the subject is considered desirable.

Salary scale £1700 by £75 to £2000 with Superannuation and Family Allowances.

Form of application and further particulars may be obtained from the Secretary of the College.

E7943

TENDERS

COUNTY BOROUGH OF BRIGHTON

WATERWORKS DEPARTMENT

MILE OAK PUMPING STATION

TENDERS invited for MANUFACTURE, DELIVERY, ERECTION, TESTING and MAINTENANCE of THREE ELECTRICALLY-DRIVEN SUBMERSIBLE WELL PUMPS and FIVE BOOSTER PUMPS with Control Gear and other Appurtenant Works.

Specification and particulars from Waterworks Engineer, 12, Bond Street, Brighton, 1, on payment of five guineas deposit, to be refunded on receipt of a bona-fide Tender and return of all documents.

Tenders, in plain, sealed envelopes, endorsed "Tender for Pumping Plant, Mile Oak," to be delivered to me by noon on 23rd August, 1958.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. O. DODD,
Town Clerk.

Town Hall,
Brighton, 1.
June, 1958.

E7875

TENDERS

INDIA STORE DEPARTMENT

HYDRAULIC 4-COLUMN PORTAL PRESS

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

18022/1/GNK/HAL
HYDRAULIC 4-COLUMN PORTAL PRESS—1 off—capacity 1000 tons, clearance bet : columns 4200mm. ; stroke of ram 500mm.

The Tender forms with schedules and specifications which are returnable on Thursday, the 7th August, 1958, may be obtained from the above office (CDN Branch) on payment of a fee (which is not refundable) of ten shillings for each Tender.—Applications for Tenders should clearly state the reference number of the tender required. E7934

EDUCATIONAL

BURSARIES IN STRUCTURAL STEELWORK

BURSARIES PROVIDED BY THE BRITISH STEEL PRODUCERS CONFERENCE AND THE BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION ARE AVAILABLE FOR THE NEW POSTGRADUATE COURSE IN STRUCTURAL STEELWORK DEALING WITH THE APPLICATION OF MODERN ANALYTICAL AND DESIGN METHODS TO PRACTICAL DESIGN PROBLEMS.

Students will take appropriate parts of the new postgraduate course in engineering structures which will include : analytical techniques for highly indeterminate systems ; theory of elasticity and its application to stress distribution problems, bending and torsion of beams, bending of plates ; buckling of columns, beams, plates and plate stiffener combinations, basic principles of design ; plasticity, including limit analysis theorems, collapse load calculations, displacement calculations, effects of shear and axial loads, plastic stability of struts and frames, shakedown analysis, minimum weight design ; photoelastic and other laboratory techniques ; laboratory experiments to illustrate the above topics.

The design side of the course will include design of connections (riveted, welded, bolted), components (struts, ties, rolled beams, light gauge components, plate girders, vierendeel girders, castella beams), ultimate strength, fatigue behaviour, load factors, safety concepts ; elastic simple semi-rigid, rigid, composite and plastic design of single and multi-storey frames ; design of bridges, towers, gantries, bins and tank structures. The course will deal with the administration of steelwork design, economics, contract documents, relation between client, designer and contractor, organisation of work, responsibilities and liabilities. Drawing-office work will include a design project and report. In addition to laboratory work, opportunities exist for observing the actual behaviour of building structures under construction at the College.

THE VALUE OF BURSARIES IS FROM £475 TO £775, FROM WHICH FEES (£64) WILL BE PAYABLE FOR THE PERIOD OCTOBER, 1958–JULY, 1959. APPLICANTS MUST HAVE A GOOD FIRST DEGREE IN CIVIL ENGINEERING OR EQUIVALENT QUALIFICATION AND PREFERABLY SOME PRACTICAL EXPERIENCE IN STRUCTURAL STEELWORK DESIGN.—APPLICATION SHOULD BE MADE TO : THE REGISTRAR, IMPERIAL COLLEGE, LONDON, S.W.7, BY JULY 30th, 1958. E7957 B

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E.,
A.M.I.Chem.E., A.M.I.M.I.,
A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 B

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 B

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A TECHNICAL ASSISTANT for the Works Director is required by a medium-sized precision engineering company in Surrey. Applicants should be qualified Production Engineers aged 35 to 45 years, and possess either B.Sc. (Eng.) or A.M.I.Mech.E. Practical commercial experience is essential. Salary, £1200 to £2000, according to age and experience. The prospects for the right man are very good. Applications, which will be treated in strict confidence, should give the fullest details of career, health and present occupation.—BOX No. E1960, "The Engineer." A

Classified Advts. continued on page 132

SITUATIONS VACANT

A TEAM OF ENGINEERS is being formed which will require personnel in the following categories :

Fully trained and experienced PRODUCTION ENGINEERS of Degree Standard or equal to study shop floor methods, develop and supervise the installation of machinery and arrange for its manufacture.

MACHINERY DESIGNERS of not less than H.N.C. Standard.

DRAUGHTSMEN.

The work will include the design and development of new and existing high production special purpose machinery and the development of new products.

Experience in sheet metal machinery or high-speed automatic production an advantage.

Apply in confidence to Works Manager, The Expanded Metal Co., Ltd., Stranton Works, West Hartlepool. E7958 A

A WELL-KNOWN COMPANY with large resources is about to form a subsidiary company in the light engineering field for which it requires two top executives. Men who have extensive experience of the slotted angle industry would be particularly adapted to meet requirements. The positions to be filled are :

COMMERCIAL MANAGER
PRODUCTION MANAGER

The prospects for advancement are good and either of the men selected may, after a period of 6 months to 1 year, be offered Directorships. The remuneration will be substantial.

Only men of the highest ability and proven success in commercial management, on the one hand, and production management, on the other, should apply.

The company is not concerned with the slotted angle industry, nor has it connections with this industry. Applications will be treated in strict confidence.

Applicants should state fullest details of their experience and also their age and present salary. —Apply, BOX 163, c/o Walter Judd, Ltd., 47, Gresham Street, E.C.2. E7917 A

A WELL-KNOWN GENERAL ENGINEERING COMPANY in the North West of England, a subsidiary of a world-renowned American concern, is about to appoint a CHIEF INSPECTOR, responsible to the General Works Manager, to take complete charge of all inspection functions throughout their recently expanded factory. Candidates should be first-class engineers, fully experienced in the control of labour and must at present hold a similar position. Please reply, stating age, qualifications, experience, salary required and present salary.—BOX No. E7912, "The Engineer." A

AN EXPERIENCED DRAUGHTSMAN-DESIGNER, required for rapidly expanding Engineering organisation. Used to modern methods of plant layout, initiation of special purpose machinery, conveyorisation, boiler house practice and usual factory ancillary services. This post calls for a man of ability to translate production needs efficiently and offers a progressive future. Age 25–45 years. Apply in first instance, stating technical qualifications, experience, and salary required.—BOX No. E1965, "The Engineer." A

APPLICATIONS ARE INVITED from those with ambition to join expanding sales organisation. Successful applicant will be required to operate from Manchester and will be responsible direct to principal. Must have sound engineering background, and possess current driving licence, age 30–40.—BOX No. E7952, "The Engineer." A

ASSISTANT TO MANAGER
MOBILE AND CIVIL ENGINEERING PLANT DEPARTMENT

Owing to expansion within the Division, an Assistant is required to the Manager of the Mobile and Civil Engineering Plant Department.

The successful candidate will be expected to carry out under the Manager's instruction, detail work in correspondence, costing, manpower, development, investigations, and new projects. He will be required to learn the department's functions, both operational and technical and will be trained to deputise for the Manager in co-ordinating the main sections of the Department.

Applications are invited from Engineers under the age of 25, who have completed their National Service, with at least a working knowledge of internal combustion engines, and a flair for mobile plant and mechanical handling.

They should have their Higher National Certificate in Mechanical Engineering or its equivalent.

Those wishing to apply should write giving full details of age, experience, present salary, and any further information considered necessary to :

Superintendent Personnel Services,
THE STEEL COMPANY OF WALES, LTD.
(Steel Division),
Abbey Works,
PORT TALBOT, GLAM.
E7942 A

BRITISH TRANSPORT WATERWAYS invite applications for ENGINEER (Maintenance and General) in their office at Watford. Salary range £1285–£1560 p.a. with Superannuation Scheme and certain Privilege Railway facilities. Applicants must be Associate Members of the Institution of Civil Engineers and have had a wide experience in design and construction of Civil Engineering Works, both by Contract and Direct Labour. Particular emphasis on hydraulics in connection with River and Canal Works and of structures in Concrete, mass, reinforced, prestressed, and steel. Experience in specification and Bills of Quantities is essential.—Applications stating qualifications, experience, present salary, to be addressed to Staff and Establishment Officer, British Transport Waterways, 163, Euston Road, London, N.W.1., by 26th July, 1958. E7948 A

DRAUGHTSMAN, experienced in the design and development of agricultural machinery ; opportunities for advancement for suitable applicant.—BOX No. E1982, "The Engineer." A

BRITISH PETROLEUM COMPANY LTD. invites applications from young GRADUATES, aged 23–26 years, with an honours degree in Petroleum Engineering, Engineering or Physics for employment as Petroleum Engineers with its associates in TRINIDAD. Duties will consist of assisting in all aspects of field production work, including well control, artificial lift, gas control, oil collection and well servicing. National Service obligations must have been fulfilled.—Write, stating age and full details of qualifications and experience, quoting T.3, to BOX 3107, c/o 191, Gresham House, E.C.2. E7927 A

DESIGN ENGINEER capable of producing practical ideas giving guidance to draughtsmen and being responsible for finished drawings and specifications, required by large modern firm producing Pressure parts for varying services and temperatures. A knowledge of combustion and light foundry work an advantage. Drive, initiative and good technical qualifications essential. Excellent prospects for right man.—State age, experience and present salary.—BOX No. E7953, "The Engineer." A

DESIGNER DRAUGHTSMAN (MECHANICAL) required for Research and Development Team engaged on interesting development work in connection with special structures and diesel and steam operated plant. Minimum qualifications, O.N.C. Age group 24–30 years. The appointment is permanent and progressive in an expanding organisation. Contributory Pension Scheme and good canteen facilities. Salary in accordance with age, qualifications and experience. The works are situated 15 (fifteen) minutes 'bus journey from the centre of Ipswich.—Applications to Personnel Officer, THE BRITISH STEEL PILING CO., LTD., CLAYDON, SUFFOLK. E7950 A

DRAUGHTSMEN.—Senior Material Handling and Structural men with at least ten years' experience in either field. Vacancies in our London and Bromley offices. Bonus and pension schemes. Holidays will be honoured.—Reply to JOHN WILSON & CO. (ENGINEERS), LTD., 30A, Widmore Road, Bromley, Kent. E1959 A

DRAUGHTSMEN

Experienced Draughtsmen required, used to design of colliery and/or mechanical handling equipment. Good opportunities and permanent situation available.—Apply in writing, stating age, experience, qualifications, etc., to :

QUALTER, HALL AND CO., LTD.,
P.O. Box 8, Railway Foundry, Barnsley.
E1967 A

DUE TO AN EXPANDING DEVELOPMENT PROGRAMME by a progressive Company 25 miles north of London, vacancies exist for DESIGN DRAUGHTSMEN with experience in design of transmission units for use in Earth Moving Equipment. Applicants should possess H.N.C. and be capable of developing schemes to production stage. Houses available to successful applicants after working a trial period.—Please apply to BOX No. E1984, "The Engineer." A

ELECTRICAL ENGINEER required for an expanding medium/heavy Engineering Company of repute situated in North West England. This is an important post for a man between 30 and 45 years of age, well versed in electronics, and who for preference has had experience in mechanical engineering. The successful candidate must be capable of taking complete charge of the electrical development side of an entirely new project hitherto only manufactured by the American Parent Company of the organisation, but which is now to be produced in England, and he will also be in charge of and responsible for the satisfactory operation of this equipment in the field. It is contemplated that he will spend some months in America to become acquainted with all aspects of this new project. In addition he will be required to assume control of all electrical development work within the organisation. This is an excellent opportunity for a man with ability and the right background, and a generous superannuation scheme is in operation.—Write, giving full details of age, education, technical qualifications, experience to date, salary required, &c., to BOX No. E7928, "The Engineer." A

ENGINEERING CONSULTANTS require for their London Office a professionally qualified CHEMICAL DESIGN ENGINEER to take control of Chemical and associated plant Department. Duties entail project development and design layouts and also supervision of site duties. This is a senior executive appointment and candidates are invited to forward applications outlining history of experience and qualifications and positions held to date together with details of corresponding scales of emoluments for each appointment.—BOX No. E7935, "The Engineer." A

ERECTION ENGINEER.—Suitably experienced man required to take charge of erection of aerial ropeways abroad. Excellent climate and conditions ; 18 to 24 months' initial contract.—BOX No. E1968, "The Engineer." A

GRADUATE CIVIL ENGINEER

required by Building Firm of national repute to act as Resident Engineer/Agent in charge of building projects in U.K. Youth, determination, enthusiasm and integrity required. Must be prepared, if necessary, to reside temporarily away from London.

First class salary and prospects. Post permanent and pensionable.—Write in confidence to BOX No. E7947, "The Engineer."

FIRST-CLASS WORKSHOP FOREMAN REQUIRED for civil engineering contractors' main plant depot. Must be fully experienced in all classes of workshop practice, repairs and maintenance, a good organiser and preferably with administrative experience. Applications in writing, giving full details.—BOX No. E1980, "The Engineer." A

JUNIOR PRODUCTION ENGINEER for progressive organisation. Excellent prospects. Pension and insurance benefits.—Matisa Equipment Limited, Hanworth Lane, Chertsey. E1963 A

K. S. PAUL (MOLYBDENUM DISULPHIDE), LTD., Park Royal Road, N.W.10, require for Technical Sales Department APPLICATION ENGINEER, to advise customers on difficult lubrication problems. London based. Applicant must be keen, energetic, loyal. Excellent prospects for advancement.—State salary, experience, age, in confidence, to Managing Director. E1974 A

MAINTENANCE ENGINEER. Preferable with building experience for medium size company West London. Wood and Allied Trades. Applicants interested in hard work and achievement rewarded—others need not apply. Salary according to ability, experience and personality. Minimum £620 p.a. Practical journeyman and sound supervisor required. Incentives/Bonus.—BOX No. E1983, "The Engineer." A

MECHANICAL ENGINEER required by North London Engineering Company. Experienced in design of medium-sized automatic special purpose machines. Accustomed to initiative and responsibility. Qualifications, H.N.C. or equivalent preferred. Salary from £1000 per annum, according to age and experience. Pension scheme. Apply.—BOX No. E7909, "The Engineer." A

PERA is carrying out research to develop new metal forming and machining techniques and improve cutting tool performance. Engineers, age group 24–32, anxious to apply their technical knowledge are invited to apply for staff positions. Status and salary will depend on age, qualifications, and experience. Career details should be sent to the Secretary, PRODUCTION ENGINEERING RESEARCH ASSOCIATION, Melton Mowbray, Leics. E7906 A

PLANNING ENGINEER

Planning Engineer required for control of Planned and Scheduled Maintenance Scheme covering approximately 450 men. Minimum technical qualifications, H.N.C. plus good apprenticeship. Previous experience of this type of work, including supervision, desirable. Age 25–35 years. Good salary and prospects for suitable applicant. Staff conditions of employment include good pension scheme, 5-day week, canteen facilities. Applications, in writing, should state age, qualifications, experience in sequence and be addressed to Personnel Manager, British Enka, Ltd., Aintree, Liverpool. E7939 A

RESEARCH AND DEVELOPMENT ENGINEER

An Engineer is required as Assistant to the Research and Development Manager of a company manufacturing friction materials. A thoroughly digested Degree, the ability to work hard, and the knack of getting on with people are qualities which will be regarded as important. A house in a pleasant North Country district can probably be made available in a reasonable time, otherwise assistance with the purchase of a house will be given. Age level, early thirties. Brief details of experience and qualifications should be sent, and interviews will be arranged for all suitable applicants. All applications will be treated in strict confidence.
BOX No. E1985, "The Engineer." A

SENIOR DRAUGHTSMAN required for Drawing Office Section engaged on the application of small diesel engines to marine propulsion. Experience on this type of work is essential. There is every likelihood that this section will expand considerably in the near future and the successful applicant will have the opportunity of promotion to Section Leader. Excellent salary and conditions of employment, including non-contributory pension scheme.—Apply in writing, giving full details to the Chief Personnel Officer, Petters, Ltd., Causeway Works, Staines, Middx. (Tel.: Staines 1122.) E7964 A

SENIOR DRAUGHTSMAN, over 35, required by Midland firm to handle all mechanical and electrical details of contracts for pumps, pipework, control gear, &c. Some supervision experience necessary. Superannuation scheme available. Minimum starting salary £900.—BOX No. E7956, "The Engineer." A

SENIOR ELECTRICAL ENGINEER

International Combustion Limited, Derby, have a vacancy for a Senior Electrical Engineer to take charge of all projects involving electrical and control gear.

Further details on request. Highest salary paid to suitable candidate.

Reply, giving full particulars, to :
Chief Engineer,
International Combustion Limited,
Derby.
E7771 A

SENIOR TOOL DESIGNER required by Diesel Engine Manufacturers. The successful candidate will be required to design and detail all types of tooling for the production lines. He must be experienced in the location and clamping of all types of components, cutter and gauge design and should preferably have had at least 5 years jig and tool design experience with previous knowledge of tool room work. It is necessary for the candidate to hold at least an Ordinary National Certificate.—Please apply in writing, giving full details of experience, age and salary required to the Chief Personnel Officer, Petters, Ltd., Causeway Works, Staines, Middlesex. E7926 A

WORKS MANAGER

Applications for position of Works Manager are invited by a well-known firm of Engineers in the East Midlands engaged in the manufacture of high-class special machinery and general engineering.

Candidates should be between 35 and 40 years of age, having served a period as Works or Student Apprentice and have the qualification of Higher National Certificate in Mechanical Engineering or equivalent. Some experience in management and up-to-date methods is essential.

The appointment to commence mid-September or early October.—Write, giving details of age, experience and qualifications to BOX No. E7933, "The Engineer."

All applications will be treated in confidence.

WORKS MANAGER required for road tanker manufacture and general fabrication. View to becoming General Manager. Large expansion envisaged. Salary according to experience and qualifications. House provided if necessary.—Apply, "Dewco," Bellshill, Scotland. E7879 A

SENIOR DRAUGHTSMAN

required aged 24-28, for the Engineering department in London of a fast-growing and famous manufacturing organisation.

The successful candidate will have a sound educational background, preferably to H.N.C. level, and will have followed a recognised apprenticeship. He will also possess experience and knowledge of machine design and Plant layout work.

This position provides a valuable opportunity for a person of ambition and ability, and offers an attractive starting salary. A Pension Scheme ensures security.—Write fully, with details of age, education and experience to BOX No. E7932, "The Engineer." A

MSL have been retained to advise on the appointment of a

WORKS MANAGER

for a company in the London Area engaged in the light engineering and woodworking industry. The company, which employs approximately 100, is a member of a well-established group with a high reputation, and has plans for further expansion.

The Works Manager will be responsible for all aspects of manufacture, methods, production planning and control, and will take an active part in the future development plans.

Candidates must have attained a position of responsibility preferably as production or works manager, and have experience in light engineering shop practice, work study, and modern control procedures. A mechanical engineering apprenticeship with a degree or other professional qualification is desirable, while experience of woodworking and electrical engineering would be an added recommendation.

Age 35–40. Commencing salary up to £2,000 according to experience with good prospects of a local directorship within 6/12 months. The company operates an attractive profit sharing and pension scheme.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.1049, to M. B. Berks.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E7914 A

BOOKS and PUBLICATIONS

A History of Technology

Edited by CHARLES SINGER,
E. J. HOLMYARD, A. R. HALL, *and others*

Each Volume, £8. 8s. net

VOLUME I:

From Early Times to Fall of Ancient Empires c. 500 B.C.

884 *pages, 37 plates, 570 figures, maps, and tables*

'For the general reader there is every incitement that narrative and illustration can provide; for the scholar there are bibliographies, notes and special sections in which the very latest archaeological evidence is adduced and evaluated. If subsequent volumes of this history match the standard of the first, a great piece of collaboration between science and humanism will have been accomplished.' *Economist*

VOLUME II:

Mediterranean Civilization and the Middle Ages c. 700 B.C. to A.D. 1500

800 *pages, 45 plates, 700 figures*

'This magnificent book will be a necessity in every reference library and a joy to anybody who is lucky enough to own a copy.' *Manchester Guardian*

'Everyone will hope for a speedy publication of the entire set of volumes which will constitute a magnificent crown to the achievement of Charles Singer, the greatest living British historian of science, medicine, and technology.' *Cambridge Review*

VOLUME III:

From the Renaissance to the Industrial Revolution c. 1500 to 1850

804 *pages, 33 plates, 426 figures*

'This book is as huge, lively, diverse, and intelligent as the astonishing age it describes.' *Technology*

'The volumes of the *History of Technology* continue to appear at a speed that is rare for works of collaborative scholarship, and their interest heightens as they approach modern times.' *Economist*

JUST PUBLISHED

VOLUME IV:

The Industrial Revolution c. 1750 to 1850

800 *pages, 48 plates, 349 figures*

FORTHCOMING

VOLUME V:

The Late Nineteenth Century c. 1850 to c. 1900

880 *pages, 42 plates, 415 figures*

Ionized Gases

A. VON ENGEL

292 *pages, 144 figures, 42s. net*

'This is a very good introduction to the quantitative study of ionized gases . . . it contains a surprisingly large amount of information. . . .' *Transactions of the Faraday Society*

'. . . there have been few comprehensive books on this subject which achieve the same standards of clarity in elucidating the basic physical principles. Dr A. von Engel's book is outstanding in this respect . . . . an excellent book which will appeal particularly to final-year students and to those embarking on research in this subject.' *Nature*

OXFORD UNIVERSITY PRESS

SITUATIONS VACANT

BRITISH OXYGEN ENGINEERING LIMITED

MECHANICAL DEVELOPMENT ENGINEERS

Applications are invited from Mechanical Engineers to join a Team engaged on development work for Plants operating at low temperatures.

The work offers considerable scope to Engineers who wish to enlarge their experience in new fields of endeavour, and will involve the design of new processes and components, including pressure vessels, various types of machinery and heat exchangers.

Qualifications to the standard of a good Degree or equivalent are required and/or previous experience on plant development work.

Excellent salaries and conditions of service are offered and assistance with HOUSING may also be given.

Applications, giving full details, should be sent to :—

Employment Officer, (E/2)
BRITISH OXYGEN ENGINEERING LIMITED
Angel Road, Edmonton, London, N.18

E7960 A

CONTRACTS ENGINEER

(Commercial)

REQUIRED FOR

MAYBACH DIESEL DIVISION OF ARMSTRONG SIDDELEY MOTORS LIMITED

at COVENTRY

This is a new senior, permanent and pensionable appointment and will interest people with a good technical and commercial background particularly in rail traction and marine propulsion, and who are capable of undertaking complete responsibility for the drafting and administration of U.K. and overseas long and short term contracts. Written applications giving age, qualifications, experience and salary required will be treated in strict confidence and should be addressed to :

SALES MANAGER,
Special Projects,
ARMSTRONG SIDDELEY MOTORS LIMITED, COVENTRY

E7852 A

RESEARCH IN MECHANICAL ENGINEERING

A vacancy exists for a first class man to lead a group engaged in fundamental and applied research on topics associated with mechanical strength. The work covers both theoretical and experimental aspects of the following topics:-

Strength and properties of materials.
Vibration analysis.
Stress analysis.
Mechanical structures.
Load distribution.

We expect to appoint a person who has had general experience in these fields and who has a specialised knowledge of one or more of the above aspects.

As the work has application to the full range of the Company's products the post presents a unique opportunity for a keen, qualified man to apply himself to work which it is intended should lead to a steady and continuing improvement in the effective distribution of the load carrying material in the Company's products.

Please write giving full details of age, qualifications and experience to Dept., C.P.S. Marconi House, 336/7 The Strand, London, W.C.2. quoting reference E 1917C.

E7922 A

Classified Advts. continued on page 134

SITUATIONS VACANT

R. S. T.

Applications are invited in connection with a wide range of vacancies for

MECHANICAL AND ELECTRICAL ENGINEERS

in one of the large copper mines of the RHODESIAN SELECTION TRUST GROUP

Applicants should hold a B.Sc. degree or equivalent qualification in electrical or mechanical engineering.

Basic starting salary would depend on qualifications and experience. In addition, there are generous pension, bonus, cost of living, medical and life assurance schemes.

A free outward passage is provided for successful applicants. Leave is granted at the rate of 45 to 51 days p.a. depending on status of appointment and may be accumulated over three years' service.

The mine townships are pleasant garden cities with excellent recreational amenities.

Send full particulars to :
Mine Employment Department,
Selection Trust Building,
Mason's Avenue, Coleman Street,
London, E.C.2.
PLEASE QUOTE R.51.

E7913 A

SITUATIONS VACANT

SENIOR SALES ENGINEER

required for PAKISTAN. Well-known English Company with rapidly developing business in Pakistan requires Sales Engineer fully qualified and experienced in air conditioning, refrigeration and dust control. Must be capable of handling all phases of large contracts and able to take full responsibility for Branch Office in KARACHI after short training period in England. Minimum starting salary £2500 (and housing and other allowances) to suitable applicant, with excellent prospects. Write immediately in confidence, for interview in London.—BOX No. E7968, " The Engineer."

SITUATIONS VACANT

ENGLISH ELECTRIC
WHETSTONE Near Leicester

require

MECHANICAL DESIGN ENGINEERS
PLANT LAYOUT ENGINEERS

to undertake work on the design of

NUCLEAR POWER STATIONS

Applicants should have a H.N.C. in Mechanical Engineering and some experience in the design of layout of plant or components in the fields of heavy mechanical or chemical engineering.

Please write, giving details of education, qualifications and experience, to Dept. C.P.S., 336/7, Strand, London, W.C.2, quoting Ref. E.1817C.

E7920 A

BRITISH OXYGEN ENGINEERING LIMITED

PRODUCTION ENGINEERS
PLANNING ENGINEERS
and RATE-FIXERS

Applications are invited from Engineers for production engineering work and rate-fixing connected with the fabrication and workshop erection of Chemical Plant. A good practical engineering background is required and experience in at least one of the following is essential:

PROCESS PLANNING of fabrication work in copper, aluminium and stainless steel.

RATE-FIXING applied to the fabrication or workshop erection in Chemical Plant.

WORK-STUDY as applied to the fabrication and workshop erection of Chemical Plant.

MODERN WELDING TECHNIQUES as used on non-ferrous metals.

Excellent salaries and conditions of service are offered for these posts and assistance with HOUSING can also be given.

Apply in person, or in writing, to the Employment Officer:—
BRITISH OXYGEN ENGINEERING LIMITED,
Angel Road, Edmonton, London, N.18.

E7963A

Reed PAPER GROUP

THE REED PAPER GROUP

invites applications for the post of

SENIOR ENGINEER

in its central engineering division at Larkfield, near Maidstone, which undertakes all major engineering work within the Group. Duties will involve contact in the role of consultant with numbers of individual companies and the planning and execution of projects up to several million pounds in value.

Candidates should be between 35 to 45 ; possess a good degree in engineering and have had several years in responsible positions in industry. Paper mill experience would be an advantage but the essential requirement is proved administrative ability coupled with a sound knowledge of engineering in all its aspects, particularly mechanical, electrical and steam.

The appointment is a most senior one and will carry a correspondingly high salary. Conditions of service are excellent. Non-contributory pension scheme : Assistance with house purchase.

Applications should be made in writing to the
Group Personnel Officer, Albert E. Reed & Co. Ltd.,
Larkfield, Near Maidstone, Kent.

E7941 A

THE OPPORTUNITY FOR A SECURE FUTURE

exists with a leading Engineering Company in the NORTH WEST, newly equipped with the latest types of heavy machine tools, for a

MACHINE SHOP SUPERINTENDENT

He must be capable of guiding detail layout planning, and have a comprehensive knowledge of modern methods employed in the machining of large forgings, castings and fabrications weighing up to 150 tons for rotating plant.

He must have held a similar position either using or manufacturing heavy machine tools, where leadership and enthusiasm were necessary.

Housing and early entrance into Pension Scheme, together with a good salary, are awaiting the right man.

Please write, giving full details, to BOX E4021, LPE, Romano House, 399/401, Strand, London, W.C.2.

E7938 A

J. W. ROBERTS, LIMITED

a member of the Turner and Newall Organisation, of Chorley New Road, Horwich, near Bolton, requires the services of a

MECHANICAL ENGINEER

for a position of responsibility in their Insulation Contracts Department. Age limits about 25 to 30. Applicants should be of H.N.C. level or equivalent and preferably have served a recognised apprenticeship. Knowledge of rolling stock construction an advantage but not essential.

The post, which is permanent and pensionable, involves direct customer contacts, the practical handling of thermal and acoustic insulation problems, the organisation and periodic supervision of contract work at different sites about the country and the control of staff engaged on such work. It will appeal to men looking for interesting and varied work, with some travelling and calling for a considerable degree of self-reliance and initiative in solving practical snags and difficulties. 5-day week. Excellent canteen facilities.

Please write, in confidence, to " G.S.M.," J. W. Roberts, Ltd., Victoria Chambers, South Parade, Leeds, 1, giving age, work history and other relevant details.

E7944 A

CADBURY BROTHERS LTD.

HAVE VACANCIES FOR

DRAUGHTSMEN

for plant design and layout work, with some works experience. The National, or Higher National Certificate, though not essential, would be an advantage. Five-day week, attractive working conditions, Pension Scheme. Provision of accommodation will be considered.

Apply in writing, stating age, qualifications, experience, and salary required, to :
CHIEF ENGINEER, CADBURY BROS., LTD., BOURNVILLE, BIRMINGHAM

E131 A

SITUATIONS VACANT

ASSISTANT ENGINEER

is required by

SCOTTISH AGRICULTURAL INDUSTRIES LIMITED

to fill a vacancy on the staff of their Ayr Fertiliser Works. The minimum qualifications required are a Higher National Certificate in Mechanical Engineering but preference will be given to candidates with an Engineering Degree or A.M.I.Mech.E. Experience of plant installation and maintenance will be an advantage. The post is permanent and pensionable and the commencing salary will be according to age, qualifications and experience.

Application forms will be forwarded to suitable candidates on receipt of brief details covering age, qualifications and experience, which should be addressed to the Personnel Officer,

Scottish Agricultural Industries Limited, 39, Palmerston Place, Edinburgh, 12, quoting reference 25/Assistant Engineer.

E7865 A

AGENCIES

SITE AGENT REQUIRED, with experience in supervision of building construction, particularly in the field of precast concrete structures and accustomed to conducting negotiations with clients.—Please send full particulars of experience and salary expectation to Head Wrightson Processes, Ltd., 16–26, Baltic Street, London, E.C.1. E133 D

BUSINESSES and PREMISES

BERMONDSEY, S.E.1. Substantial three-floor modern factory, part newly constructed. Lofty floors (concreted). Steam heating. Sprinklers. 32,300 sq. ft. Yards. Immediate possession. Freehold. Low price for early sale. £67,500.—Chamberlain & Willows, 23, Moorgate, E.C.2. (MET 8001).

E7916 L

FUEL OIL AND LUBRICATING OIL PUMP MANUFACTURING AND SALES COMPANY FOR SALE. New pump proved with 2½ years' service and existing satisfied customers, requires more capital for development than owners possess: would suit large Group seeking fresh line for expansion. Drawings, patterns, test equipment, know-how, stock and sales connections: optional extra of plant, jigs and tools.—BOX No. E1987, "The Engineer." L

Close to the Shipping, Insurance and Produce Markets of the City of London

OFFICES TO LET

(Would be divided to suit requirement)

Small sections from 450 sq. ft.,

Complete floors 4000 sq. ft.

Rental from 16s. per sq. ft.

Lifts. Central heating.

Please send requirements to Joint Sole Agents,

JONES, LANG, WOOTTON & SONS, 16–17, King Street, E.C.2 (MONarch 4060).

D. E. & J. LEVY, 58, Haymarket, S.W.1 (WHItehall 0161).

E7946 L

SUB-CONTRACTING

ACCURATE MACHINING

also on Models and Prototypes, &c.

MILLING TURNING
JIG BORING PLANING
PRESS TOOLS, JIGS AND FIXTURES
HORIZONTAL BORING

GIVE US YOUR DIFFICULT JOBS

LANDEN (ENGINEERS), LTD.
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075 E115 MW

CAPACITY AVAILABLE for Production of Steel Forgings of all types by 5, 10, 15 and 20 cwt. hammers. Can give quick delivery.—Enquiries to R. Hoe and Co., Ltd., 109, Borough Road, London, S.E.1. E1975 MW

CAPACITY AVAILABLE — Planing, Milling, Drilling, Boring, Centre Lathe and Capstan, &c. Casting, Machining and Assembly of Complete Units. Fabrication work where complete assemblies are involved. One offs or repetition.—BOX No. E7955, "The Engineer." MW

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and ironfoundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E751 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design and development undertaken. A.I.D. Approved.—Bowyer, Smyth and Partners, Ltd., Vineyard Walk, Clerkenwell, E.C.1 ('Phone, TERminus 5113/4). E112 MW

DRAWING & DESIGN SERVICE

COMPETITIVE STEELWORK DESIGNS, plans and detail drawings for all kinds of buildings and structures by experienced Structural Engineers. Quick service. HOLborn 2587. E1964 S

MACHINERY Etc. WANTED

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Moseley Road, Birmingham, 12. VIC. 1278, 1279, 1270, 0856. E104 F

WANTED.—Plate End Planing Machine, to take 30/35ft. plates, clamping up to 3in. thick. Must be in good condition. Full details.—BOX No. E7856, "The Engineer." F

WANTED IMMEDIATELY

PACKAGED AUTOMATIC BOILER,

new or second-hand, 250 p.s.i. working pressure, evaporation 2000–4000 lb./hour, suitable for oil firing.

Details of cost, make, age, and when and where available, to:

The Chief Engineer,
The Washington Chemical Co., Ltd.,
Washington, Co. Durham.
Tel. No.: Washington 3333.

E7962 F

LOFTY GROUND FLOOR FACTORY/WAREHOUSE

KENNINGTON, S.E.11

(very close to VAUXHALL BRIDGE)

LONG LEASE AT LOW RENTAL FOR DISPOSAL.

Total COVERED Floor area 21,500 sq. ft.

HEIGHT of 20ft. over MAIN AREA. Good VEHICULAR ACCESS.

IMMEDIATE OCCUPATION.

Full details from Owners Agents:

MILLS & WOOD, *Factory Agents and Valuers*

30, Fleet Street, E.C.4. FLEet St., 4754.

E7961 L

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 ('Phone, SLOane 5259). E103 K

HIRE A £1500 CAMERA FOR ONLY £5. All other types of photographic equipment available.—B. Bennett and Sons, Ltd., 25/27, Oxford Street, London, W.1 (Telephone, GERard 9953). Catalogue on request. E128 K

FOR SALE

CENTRAL ELECTRICITY GENERATING BOARD

LONDON DIVISION

OFFERS are invited for the PURCHASE and REMOVAL from Barking "A" & "B" Generating Stations of the following:—

ONE STEAM LOCOMOTIVE, maker Hunslet Engine Co., type 0-4-0 Saddle Tank. Rail gauge 4ft. 8½in., No. 1878, with associated spares. Condition: Used repairable condition.

For permission to view and conditions of Tender application to be made to the Divisional Purchasing Officer, Central Electricity Generating Board, London Division, Generation House, Great Portland Street, London, W.1, not later than the 25th August, 1958. E7951

HORIZONTAL MILLING MACHINES

ARCHDALE 28in. Manufacturing and General Purpose All Geared Horizontal Milling Machines; tables 49in. by 13in., spindle speeds 30–462 r.p.m., motors 6 h.p.

F. J. EDWARDS, LTD.,
359–361, Euston Road, London, N.W.1.
EUSton 4681 and 3771.

E7931 G

HYDRAULIC PRESSES

Unused 4000-ton HYDRAULIC HEAVY PLATE FORMING and BENDING PRESS, table 18ft. by 10ft., weight 380 tons.

2000-ton DOWN-STROKE HYDRAULIC FORGING PRESS, ram 31in. dia., admits 8ft. 7in. wide, with horizontal sliding table, weight 200 tons.

1000-ton DOWN-STROKE PRESS by Loewy Eng., ram 27in. dia., bed 40in. by 48in.

650-ton DOUBLE-ACTION DRAWING PRESS, by Lake Erie, bed 7ft. 6in. by 6ft. 8in., with self-contained pump unit.

MANY OTHER HYDRAULIC PRESSES OF ALL TYPES

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone: Woolwich 7611/6.

E7954 G

FOR SALE

HICYCLE PLANT—B.T.H. Frequency Changer, r.p.m. 2930, 6 poles, input 400/420/440V., 16/15 amps, 3 ph., 50 cycles, output 127V, 114 amps., 3 ph, 200 cycles, kVA 25, PF. 0·8.

High Frequency Hand Grinding and Polishing Machines. Large stock of mops, bobs, stones, etc., also one Sedgewick segmented blade bending and folding machine, fully motorised, capacity 8ft. 3in. by ¼in., 4ft. 7in. by ⅛in., 3ft. 5in. by ¼in., installed only 18 months.

For further details or viewing, write C.W.S., Ltd., Dairy Equipment Works, Upminster. Tel.: Upminster 3200. E7905 G

DAVEY PAXMAN COMPOUND HORIZONTAL STEAM ENGINE, direct coupled to 160 kilowatt 480 volt d.c. generator, with grooved flywheel, complete with condenser, air and circulating pumps and oil separator.

CROMPTON PARKINSON DIRECT COUPLED MOTOR GENERATOR, 25 h.p., 480 volt d.c. motor driving 16 kilowatt 240 volt d.c. generator, complete with Brookhirst Starter and Switchboard.

Available inspection East London.—BOX No. E1981, "The Engineer." G

TAYLOR No. 2 CUTTING-OFF MACHINE. Rotary Tool type, **BALLINGER C.10 ABRASIVE CUTTING-OFF MACHINE**

H. BELL (MACHINE TOOLS), LTD.,
Walter Street, Leeds, 4.
Tel. 63-7398. E105 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary; cab control, 400/3/50.

40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary; cab control, 400/3/50.

40-ton Adamson, standard cab control, 42ft. 3in. span, 400/3/50.

20-ton Vaughan, standard cab control, 42ft. 3in. span, 6-ton auxiliary; 400/3/50. EIGHT AVAILABLE.

10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.

Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices about one-third of New.

FRED WATKINS (ENGINEERING) LTD., COLEFORD, GLOS.
Tel.: Coleford 2271/2/3. E132 G

FOR SALE

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia. 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Broomwade 400, 300, 200 and 130 cu. ft.; all motorised; Reavell Rotary Blowers, 2000 c.f.m., 3–2 p.s.i.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 300 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib; 4-ton Coles Diesel-Electric; 3-ton Jones Super 40 (3); Neals 2-ton Diesel, 20ft. jibs (2); Derrick, 5-ton Butters Electric travelling type, 90ft. jib; 5-ton Wilson Electric 70ft. jib; 3-ton Rushworth Electric, 65ft. jib; Steam Loco, 18-ton Brownhoist, 50ft. jib; 10-ton Coles, 40ft. jib; 8-ton Wilson, 35ft. jib; 5-ton Smith, 50ft. jib; 5-ton Cowans Sheldon, 50ft. jib; 3-ton Grafton, 38ft. jib; E.O.T., 40-ton Adamson, 42ft. span; 20-ton Vaughan, 42ft. span (3); Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris; 5-ton Henderson, 24ft. 7½in. span, 1946; 5-ton King, 29ft. 3in. span; 2-ton Morris, 18ft. span, 2-ton Smith, 34ft. span.

RAILWAY MATERIAL.—Hunslet 0-6-0, 18in. by 26in. cyl.; Bagnall 0-4-0, 14in. by 22in.; 150 h.p. Stephenson Diesel Loco., fluid flywheel drive; Ruston 80/88 h.p. Diesel Loco., electric start, flameproof; Peckett 14in. by 22in. and 7in. by 12in. Steam Locos.; 3 miles 20 lb. Track, 24in. gauge bogies, turnouts, locos, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new; 60,000ft., 3in. black new; 5000ft. 8in. seamless; 1000ft. 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¾in.; Robertson Straightening Rolls, 8ft. 6in. by ¾in.; Berry Bending Rolls, 7ft. by ¾in.; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, ¾in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers.

SLING ENGINEERING WORKS,
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E106 G

LOCOMOTIVES FOR SALE AND HIRE

14×22	040	BARCLAY
A selection in stock.		
17×24	040	BAGNALL
A selection in stock.		
18×26	060	BAGNALL

Insurance reports available.

R. S. HAYES, LTD.,
BRIDGEND, GLAMORGAN.
'PHONE: 1311/2/3. E119 G

TWW

TWO BRADLEY & TURTON FOUR COLUMN DOWNSTROKE HYDRAULIC PRESSES; capacity 350 tons at 2 tons p.s.i. working pressure, fescolised ram 15½in. dia., stroke 24in., daylight 37in., platens 37in. by 40½in., 4in. dia. push back rams, 1½in. dia. ejector rams, prefill tank mounted on top of crosshead, and intensifier, input 1500 lb. p.s.i.

ONE FAWCETT PRESTON FOUR COLUMN DOWNSTROKE HYDRAULIC PRESS, 200 tons capacity at a working pressure of 1500 lb. p.s.i., fescolised main ram 20in. dia., stroke 24in., daylight 40in., distance between columns 26½in., push back rams, ejector ram and prefilling tank.

ONE BRADLEY & TURTON DOWNSTROKE FOUR COLUMN HYDRAULIC PRESS, 150 tons capacity at 1500 lb. p.s.i. working pressure, dia. of ram 17in., stroke 18in., daylight 29½in., platens 30in. by 28in., distance between columns 36in., fully guided top platen, push back rams, ejector and prefilling tank.

ONE SHAW COLUMN UPSTROKE HYDRAULIC PLUNGER PRESS, fescolised ram 19in. dia. at 1500 lb. p.s.i. working pressure, stroke 17in., daylight 40in., platen size 30in. by 28in., distance between columns 36in.; the Crosshead houses an 8in. dia. cylinder and ram, stroke of ram 15in., pull back rams and prefilling tank.

THOS. W. WARD LTD.

ALBION WORKS - - SHEFFIELD
'Phone: 26311. 'Grams: "Forward."

E217 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel., Bexleyheath 305).

E113 G

Classified Advts. continued on page 136

FOR SALE

BRAITHWAITE SECTIONAL STEEL TANKS

Three 16ft. by 16ft. by 8ft. by 12,800 gallons—on 30ft. Steel Towers.
One 8ft. by 8ft. by 8ft. by 3200 gallons—on 24ft. Steel Tower.
£635 lump sum—" as now standing."—BOX No. E7871," The Engineer." G

1957 RAPIER 7-TON FAST STANDARD DIESEL MOBILE CRANE on pneumatics, Perkins elec. start engine, power steering, Eaton 2-speed driving axle. £1500 below new price.

WILLIAM R. SELWOOD, LIMITED,
CHANDLER'S FORD, HANTS.
'PHONE : 2275.
E7939 G

SOAG

SWIFT 48IN. SWING
SURFACING AND BORING LATHE
MODEL 12SVS. LATE TYPE.

Swing over bed 28in., over saddle 17½in., in gap 48in. by 24in., spindle bore 4¼in., 18 spindle speeds 4-230 r.p.m., 15 h.p.
In sound condition throughout, ready for work.

SOAG MACHINE TOOLS, LTD.,
JUXON STREET, LONDON, S.E.11.
'Phone : RELiance 7201.
'Grams : Sotoolsag, London, S.E.11.
E212 G

600
COMPRESSOR SET

500 c.f.m. BELLISS and MORCOM, 100 p.s.i., with 550 h.p., Crompton Parkinson motor, 3·3kV, or 400/440/3/50.
1550 c.f.m. BELLISS and MORCOM, 100 p.s.i., with 328 h.p. slipring motor, 400/3/50.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and
STANNINGLEY, NR. LEEDS.
Tel.: Pudsey 2241. E203 G

FOR SALE

Edwards

JOHN HANDS Double-Sided Friction Screw Press, arranged motor drive for 400/440/3/50, fitted with Broughton Automatic press guard, pressure exerted approximately 60 tons, maximum stroke 18in., tee-slotted bed 36in. by 46in. Weight approximately 9½ tons.
RHODES No. 21S, Motorised Direct Flywheel-driven, Open Fronted Inclinable Power Press, arranged motor drive for 440/3/50, fitted with automatic press guard and guard covering vee rope drive, size of bed 30in. by 21in., hole in bed 16in. by 12in., treadle-operated clutch. Weight approximately 52 cwt.
TAYLOR & CHALLEN No. 562 Double-Sided Geared Power Press, balanced drive, arranged motor drive for 400/440/3/50, pressure exerted approximately 100 tons, stroke 2in., tee-slotted bed 22in. by 20½in., clear hole in bed 10in. diameter. Weight approximately 71 cwt.
PETTINGELL Rotary Shear, mounted on cast iron box stand, suitable for cutting straight or irregular shapes on the inside or outside edge of sheets, capacity 14 S.W.G., depth of gap 60in., diameter of cutters on inclined shafts 2¾in., horse power required 2. Weight approximately 15 cwt.
QUICKWORK No. 321 Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity 14 S.W.G. mild steel, depth of shear throat 30in., diameter of cutters on inclined shafts 2in., cuts circle from 6in. to 60in. diameter, depth of gap in bow 38½in. Weight approximately 18 cwt.
BESCO High Duty Double Geared Guillotine Shearing Machine, Overcrank type, Model " R," capacity 120in. by ¼in. mild steel, treadle-operated clutch, arranged motor drive for 400/440/3/50, length 120in., depth of gap 6in., horse power required to drive 10. Weight approximately 110 cwt.
Photographs of the above are available.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.
F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
Telephone : EUSton 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 G

85 H.P. DIESEL LOCOMOTIVE, standard gauge, weight 16 tons by MOTOR RAIL
Sale or Hire.
Joseph Pugsley & Sons, Ltd.,
Bristol, 5.
Tel.: Bristol 56037. E7858 G

FOR SALE

600
HYDRAULIC PUMPS

HORIZONTAL THREE-THROW by Glenfield & Kennedy, 150 g.p.m., 1500 p.s.i., W.P. Helical gear drive, 260 h.p., S.R. motor.
HORIZONTAL THREE-THROW by Henry Berry, 50 g.p.m., 1 ton p.s.i., W.P. Double helical gear drive, 100 h.p. S.R. motor.
HORIZONTAL THREE-THROW by Fielding & Platt, 40 g.p.m., 3000 lb. per square inch W.P., D.B. reduction gear.
HORIZONTAL T.E. THREE-THROW by Fielding & Platt, 10½ g.p.m., 2 tons per square inch W.P., vee belt drive.

GEORGE COHEN,
SONS AND CO. LTD.
SUNBEAM ROAD, LONDON, N.W.10
Tel. : ELGar 7222/7.
E204 G

FOR DISPOSAL.—Two 350 h.p. " Asca " reduction geared electric motors with starting equipment. Motor speed 1420 r.p.m. Output speed 309 r.p.m., 400 volts, 3-phase, 50 cycles. All in excellent condition. Also, varying lengths of 0·2in. and 0·1in. paper insulated, lead covered and wire-armoured cables.—BOX No. E7901, "The Engineer." G

WARDS might have it!
THOS. W. WARD LTD
ALBION WORKS, SHEFFIELD

STRUCTURAL STEELWORK
SPECIALISTS IN DESIGNING & DETAILING
For all classes of Steelwork, including Buildings, Hoppers, Bunkers, Conveyors, Winding Towers, Platforms and Staircases etc.
SITE REPRESENTATION AND SURVEYS
PREPARATION OF MATERIAL AND BOLT SCHEDULES
Keith, Charnock & Partners
2 BIRMINGHAM ROAD, CASTLE HILL, DUDLEY, WORCS.
TEL. DUDLEY 5306

GUEST KEEN IRON & STEEL COMPANY

For... FERROUS AND NON-FERROUS
CASTINGS
FOR ALL INDUSTRIES

Made with the experience and skill gained by generations of craftsmen at the famous
DOWLAIS WORKS
Telephone: Dowlais 70
GUEST KEEN IRON & STEEL COMPANY LIMITED
HEAD OFFICE: EAST MOORS, CARDIFF. *Phone: Cardiff 33151*

FOR SALE

TWW

RAILS FOR SALE

100 TONS NEW SLIGHTLY DEFECTIVE B.H. RAILS, 95 lb. yard, chiefly 60ft.
100 TONS SLIGHTLY DEFECTIVE F.B. RAILS, 109 lb. yard, chiefly 60ft. lengths.
100 TONS NEW SLIGHTLY DEFECTIVE F.B. RAILS, 91 lb. yard, chiefly 42ft.
400 TONS GOOD SECONDHAND B.H. RAILS, 80/85 lb. yard B.S. section, chiefly 60ft.
100 TONS SECONDHAND BULL HEAD RAILS, 90/95 lb. yard, chiefly 44ft. 6in. lengths.
50 TONS NEW SLIGHTLY DEFECTIVE F.B. RAILS, 93·34 lb. yard, chiefly 41ft.
200 TONS NEW PERFECT F.B. RAILS, 75 lb. yard, R.B.S., chiefly 45ft. lengths.
1500 TONS NEW PERFECT BUT STOCK RUSTY F.B. RAILS, 75 lb. yard, R.B.S., chiefly 36ft.
50 TONS NEW SLIGHTLY DEFECTIVE F.B. RAILS, 80 lb. yard, revised B.S. Section, chiefly 40ft. lengths.
200 TONS SECONDHAND F.B. RAILS about 60 lb. yard, 24ft, 27ft. and 30ft. chiefly.
ABOUT 80 COMPLETE TURNOUTS, 24in. gauge, made from 20 lb. F.B. Rails, mounted on steel sleepers 15–16ft. overall.
10 TONS SECONDHAND COACH SCREWS, 6¾in. by 1¾in. standard railway pattern.
WARD'S ALSO HAVE LARGE STOCKS OF ALL CLASSES OF OTHER RAILWAY MATERIALS

THOS. W. WARD LTD.

ALBION WORKS - - - SHEFFIELD
'Phone : 26311. 'Grams : " Forward."
E215 G

VALES PLANT REGISTER LIMITED
OFFER FOR IMMEDIATE SALE

One Neals NM 2-ton Diesel Mobile Crane, Ruston engine, new 1952, on pneumatics, 25ft. jib, in good condition.
Two Jones " Super 40 " 3-ton Diesel Mobile Cranes, on solid rubber tyres, Ruston engines, 24ft. jibs, ex Ministry, little used.
One Jones " Super 40 " 3-ton Mobile Crane, 24ft. jib, on pneumatics, Ruston engine, good condition —£925.
One Jones KL44 4-ton Mobile Crane, with 40ft. jib, Ruston diesel engine, on pneumatics, new 1956, in very good condition—£3000.
One Neals QM 4/6-ton Diesel Mobile Crane with 45ft. jib, on pneumatics, Ruston engine, new 1953, in good condition.
One Coles 6-ton " Argus " Diesel/Electric Self-propelled Mobile Crane, with 40ft. jib, on pneumatics, new 1956, in good condition.
One 5-ton Anderson Grice 2-motor Electric Derrick Crane, 130ft. jib, new 1949, in very good condition.
One 7-ton Anderson Grice 2-motor type Electric Derrick Crane, 120ft. jib, new 1951, with cabin, in very good condition.
One 7-ton Butters Steam Derrick Crane, 100ft. jib, Double drum type, unused.
One 10-ton Henderson Steam Derrick Crane, 120ft. jib, first used 1954, in very good condition.
One 10-ton Coles Model S1210 Diesel/Electric fully Mobile Crane, with 30-40ft. Cantilever Jib, powered by Perkins P4 Diesel engine, new 1952, on pneumatics, in very good condition.
One 12½-ton Coles Petrol/Electric Fully Mobile Crane, with 45/80ft. jib, new 1950, reconditioned recently—£5500.
Further details, 14, Lower Grosvenor Place, London, S.W.1. Telephone : VICtoria 8080, 7531, 3501, 9886 (15 lines). E107 G

FOR SALE

3-ton Taylor Jumbo Hydraulic Crane, diesel driven.
1-ton Rapier Shop Truck Crane.
5-ton Morris Versatile diesel/electric Mobile Crane on solid rubber tyres.
5-ton Smith Steam Locomotive Crane 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super petrol/electric Mobile Crane on solid rubber tyres.
6-ton Rapier Standard petrol/electric Mobile Crane on solid rubber tyres.
Fordson Major diesel Tractor complete with Horndraulic shovel equipment.
¾ cubic yard Rapier 410 diesel driven Excavator with 4-purpose or dragline equipment.
½ cu. yd. Rapier 423 diesel-driven Excavator with shovel or dragline equipment.
1 cu. yd. Rapier 440 diesel-driven Excavator with shovel or dragline equipment.
1 cu. yd. Chasside Loadmaster " 500 " diesel-driven Loading Shovel.

WILLIAM G. SEARCH, LIMITED
WHITEHALL ROAD, LEEDS, 12.
Tel. : 639081 (10 lines).
SEARCH (LIVERPOOL), LIMITED,
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
Tel. : Simonswood 2634–5–6.
E7919 G

METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.
Motor and gearbox available separately if required.

JOHN CASHMORE, LTD.
Newport, Mon.
Tel.: Newport 66941 (6 lines).
E120 G

FOR SALE, Rushworth 8ft. by ¼in. Overcranked Guillotine, six months old, as good as new. Rhodes ¼in. by 8ft. Guillotine Overcranked welded and guaranteee by Barimar. Power-driven Planishing Hammer. One M.V. Spot Welding Machine, 25kVA., throat 2ft. 3in. Keetone 4ft. by 16G. Guillotine, undercranked, motorised, requires repair to clutch.—Bankfield Engineering Co., Ltd., Crossens, Southport. 'Phone : 87427. E1986 G

AUCTIONEERS & VALUERS

RICHARDS AND PARTNERS

Auctioneers, Surveyors and Valuers
Specialists in the
VALUATION & SALE of
INDUSTRIAL PROPERTY PLANT and MACHINERY
3, Arundel Street, London, W.C.2.
TEMple Bar 7471

JOHN FOORD & COMPANY

VALUERS AND ASSESSORS
OF WORKS, FACTORIES ENGINEERING PLANT AND MACHINERY
56, VICTORIA STREET LONDON, S.W.1.
VICTORIA 2002/3/4
Established Over a Century

KNIGHT, FRANK & RUTLEY

SALE & VALUATION OF FACTORIES PLANT AND MACHINERY
20, Hanover Square, W.1.
Telephone : MAYfair 3771
(Factory Department : Ext. 17)

FOR SALE

600

PUMPING SETS

Seven Diesel-engine-driven Pumping Sets, by CROSSLEY/SULZER, 24,000 g.p.h. at 300ft. hd. 2000 g.p.m. GWYNNE, 295ft. hd., with 250 h.p. Brook motor, 400/440/3/50.
2000 g.p.m. W. H. ALLEN, 150ft. hd., with 135 h.p. Laurence Scott motor, 400/3/50.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E201 G

HONOMETER LIP-AXIS TILTING FURNACE, with 30 cwt. capacity Iron Pot for Whitemetal and Zinc. Motorised gears. In good condition. £150 ex Works.—LANSTON VAUGHAN, LTD., 116, Strand, London, W.C.2. E1944 G

AUCTIONEERS & VALUERS

Established 1807

FULLER, HORSEY

SONS & CASSELL
Specialists IN THE
SALE & VALUATION OF
WORKS and MANUFACTORIES
ENGINEERING PLANT and MACHINERY
10, LLOYD'S AVENUE, LONDON E.C.3.
Telephone: ROYAL 4861

ESTABLISHED 1877

LEOPOLD FARMER & SONS

conduct
AUCTION SALES and VALUATIONS
OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES
FACTORY INVESTMENTS
MORTGAGES ARRANGED
46, GRESHAM STREET, LONDON, E.C.2.
Telephone: Monarch 3422 (8 lines) Telegrams: Sites, London

AUCTIONEERS & VALUERS

HENRY BUTCHER AND CO.

Auctioneers, Valuers and Surveyors
Specialising in the
SALE & VALUATION of
ENGINEERING & ALLIED WORKS PLANT & MACHINERY
73, Chancery Lane, London, W.C.2.
HOLBORN 8411 (8 lines)

Established 1850

WHEATLEY KIRK PRICE & CO.

E. L. JUDSON, F.R.I.C.S., F.A.I.
E. BIDDARD, A.I.MECH.E., F.A.I.P.A.
M. S. CHEAVIN, F.A.I.
G. E. GIBBS, F.A.I.P.A.

SURVEYORS, VALUERS and AUCTIONEERS of FACTORIES, PLANT and MACHINERY
FIRE LOSS ASSESSORS
9 REX PLACE, LONDON, W.1.
Telephone: HYDE PARK 8844/5/6 (3 lines)

E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

AUCTION PROGRAMME

		Main Location	*Auctioneers*
July 15–16	Vehicles, machine tools, miscellaneous stores, including M.T. spares, etc.	Central Ordnance Depot, Bicester, Oxon	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
July 23–24	Miscellaneous stores, including :—	M.O.S. Storage Depot, Rotherwas, Hereford	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
	Tyres, inner tubes, M.T. spares, Austin Morris, A.E.C., Dennis, Humber and other diesel and petrol engines, front and rear axles, gearboxes, marine engines and spares, towing cables, tow bars, towing assemblies, canvas covers, tarpaulins, balloon fabric, dynamos, radiators, radio and electrical equipment, building materials, platform and other scales, hoists, stacking machines, trollies, fire pumps, ladders, hand tools, paint, etc.		
July 29–30	Machine tools, textiles, electrical and miscellaneous stores	M.O.S. Storage Depot, Byley, Middlewich, Cheshire. (Sale at New Islington Public Hall, Ancoats, Manchester.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
August 26–29	Machine tools, vehicles and miscellaneous stores	M.O.S. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.	FULLER, HORSEY SONS & CASSELL (Dept. L), 10, Lloyd' Avenue, London, E.C.3. (Tel.: Royal 4861.)

Catalogues, 1s. 0d. each (P.O.s only), available only from the auctioneers shown above.

SALES BY TENDER

PRESSES.—Knuckle joint, double rack, single crank and double geared, by Bliss, Loewy, Taylor & Challen and Wellman Smith Owen, located at Yeadon, Nr. Leeds.
Tenders must be submitted by August 5th.

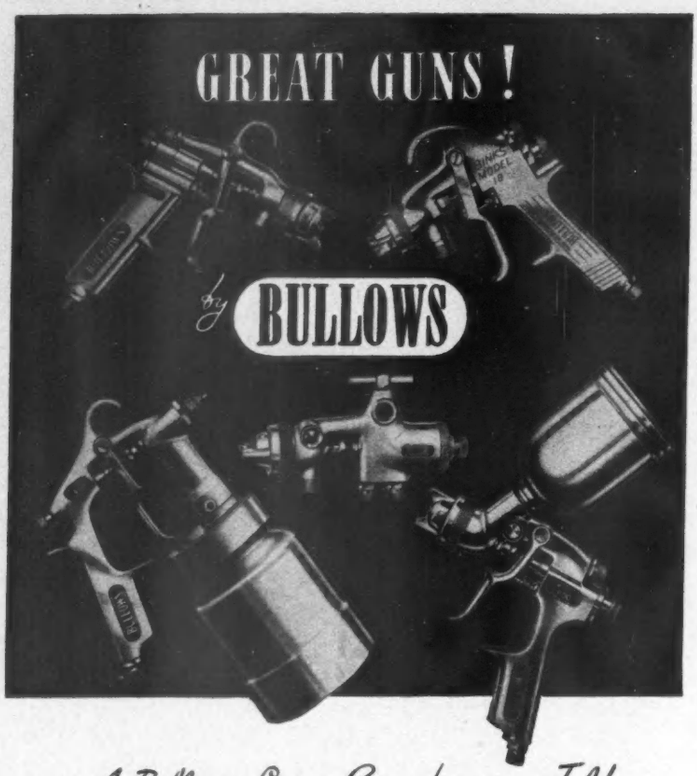
Applications for Tender Forms should be made to the Ministry of Supply, Directorate of Disposals, First Avenue House, High Holborn, London, W.C.1.

E118 J

LEAVE IT TO
Lewis
OF REDDITCH
SPRINGS, SPRING CLIPS
PRESSWORK, WIRE FORMS
VOLUTE SPRINGS

PROOF against atmospheric corrosion and many chemicals, insulated, immune to mould, happy in temperatures up to boiling point, these clips have many uses. Sizes to grip range from ¼ to 2 inches and colours available are black, white, grey, blue, red and green.

THE LEWIS SPRING CO. LTD., Resilient Works, Redditch.
Tel.: Redditch 720. PBX.
London Office: 122, High Holborn, W.C.1. Tel.: Holborn 7470 and 7479.



A Bullows Spray Gun for every Job!

AIR COMPRESSORS · SPRAY PAINTING EQUIPMENT · SPRAY-BOOTHS

ALFRED BULLOWS & SONS LTD
HEAD OFFICE & WORKS · LONG ST · WALSALL · STAFFS · ENGLAND · TEL 5001

13 SOUTH MOLTON ST., LONDON, W.1. TEL: MAYFAIR 2313 · 61/63 DRURY ST., DUBLIN. TEL: DUBLIN 73188/9
55a BRIDGE ST., MANCHESTER, 3. TEL: BLACKFRIARS 5670 · 70 GILMOUR ST., GLASGOW, C.5. TEL: SOUTH 2383

ASHWORTH ROSS DUROS

ROAD and RAIL WEIGHBRIDGES

At your service

Built to give years of trouble free service Duros Weighbridges embody all the latest improvements in design and construction and are the result of over 70 years experience in this field.

Illustrated brochures fully describing these machines are available—write for one now—without obligation.

ASHWORTH ROSS & CO LTD
Weighing Machine Makers
MIDLAND IRON WORKS, SCOUT HILL, DEWSBURY, YORKSHIRE
Telephone: Dewsbury 1760/1 *Telegrams:* "Duros, Dewsbury"

INDEX TO ADVERTISERS

PAGE

AB Atlas Copco/Sweden..... 51
Abbot Engineering Co., Ltd..... 36
Airscrew Co. & Jicwood, Ltd....140
Allday, W., & Co., Ltd..... 35
Alley & MacLellan (Polmadie), Ltd..... 26
Allspeeds, Ltd..... 80
Aluminium Wire & Cable Co., Ltd..... 121
Ames Crosta Mills & Co., Ltd. 82
Ashworth Ross & Co., Ltd... 138
Audley Engineering Co., Ltd... 37
Automotive Engineering, Ltd...108
Automotive Products Co., Ltd. 49

BTR Industries, Ltd.....102
Bache, G., & Son.....43
Barlow & Chidlaw, Ltd 27
Barr Thomson & Co.,Ltd..... 82
Beakbane, H. (Fortox), Ltd....129
Belmos Co., Ltd..... 78
Birfield Industries, Ltd 53–56
Birkett, T. M., Billington & Newton, Ltd..... 88
Birtley Engineering, Ltd..... 31
Blackstone & Co., Ltd..... 47
Boby, W., & Co., Ltd.....125
Boilerine, Ltd..... 67
Booth, J., & Bros..... 22
Braby, F., & Co., Ltd.....107
Brady, G., & Co., Ltd..... 20
Brettell Lane Foundry, Ltd.....139
Brett's Patent Lifter Co., Ltd....102
British Appliances Mfg. Co., Ltd..... 128
British Ermeto Corp., Ltd..... 7
British Rolling Mills, Ltd.....115
Brook Motors, Ltd..... 23
Broom & Wade, Ltd.....113
Brotherhood .P., Ltd.....105
Brown, J., Land Boilers. Ltd.... 4
Brownlie & Murray, Ltd..... 43
Bullows, A., & Sons, Ltd.....138
Burtonwood Engineering Co., Ltd..... 109
Butcher, H., & Co.....137

Carobronze, Ltd..... 85
Carruthers, J. H., & Co., Ltd.... 83
Clyde Blowers, Ltd..... 87
Clyde Crane & Booth, Ltd..... 22
Clyde Crane & Engineering Co. 22
Clyde Navigation Trust..... 38

PAGE

Confederation Life Association122
Conveyor & Elevator Co. (1936), Ltd..... 18
Cooper, G., & Sons.....121
Cory Brothers & Co., Ltd..... 24
Crofts (Engineers), Ltd...Cover ii
Cross Manufacturing Co. (1938), Ltd..... 18
Cummins Diesel Sales & Service, Ltd..... 58

Darlington Forge, Ltd..... 12
Darwins, Ltd..... 25
Deb Chemical - Proprietaries, Ltd..... 85
Delta Metal Co., Ltd.....118
Dilloway, P. W., Ltd..... 52
Distington Engineering Co., Ltd..... 110
Dore, J., & Co., Ltd.....129
Dorman Long..... 60
Douglas, Lawson & Co., Ltd.... 16
Dowson & Mason, Ltd..... 85
Drummond-Asquith (Sales), Ltd.....101
Du Pont de Nemours & Co. (Inc.).....114
Dunlop Rubber Co., Ltd.....119

E. & P. Designs..... 75
Eagle & Wrights (Gauges), Ltd. 65
Eagre Construction Co., Ltd.... 91
Eclipse Foundry & Engineering Co. (Dudley), Ltd..... 87
Electrical Energy.....126
Electroflo Meters Co., Ltd. Cover iv
Electronic Engineering 72-139
Electronic Switchgear (London), Ltd..... 74
English Electric Co., Ltd..... 8
Entwisle & Gass, Ltd.....106
Etchells, D., & Son, Ltd 5

Fairman Precision Tools & Products, Ltd.....102
Farmer, L., & Sons.....137
Fawcett, Preston & Co., Ltd... 98
Ferodo, Ltd.....106
Findlay, A., & Co., Ltd.....116
Finucane, W., Ltd..... 67
Firth Brown Tools, Ltd..... 79
Foord, J., & Co.....137
Fuller Electric, Ltd..... 71
Fuller, Horsey, Sons & Cassell137

PAGE

Gardiner, Sons & Co., Ltd..... 82
General Electric Co., Ltd.....10–11
Gibson .J., & Son, Ltd..... 70
Glenboig Union Fire Clay Co., Ltd..... 67
Gloucester Foundry, Ltd.....122
Goodwin, R., & Sons (Engineers), Ltd..... 18
Goodyear Tyre & Rubber Co. (Gt. Britain), Ltd..... 15
Grafton Cranes, Ltd..... 74
Greening, N., & Sons, Ltd.....126
Greenwood & Batley, Ltd..... 6
Greenwood's Standard Gear Cutting Co., Ltd..... 62
Guest, Keen Iron and Steel Co., Ltd.....136

Hall Bros. (West Bromwich), Ltd..... 20
Hall, J. E., Ltd..... 84
Harvey, G. A., & Co. (London), Ltd..... 13
Harvey Ironworks, Ltd.....102
Hayward Tyler & Co., Ltd..... 41
Heatrae, Ltd..... 62
Holmes, W. C. & Co., Ltd..... 63
Holroyd, J., & Co., Ltd..... 73
Horne Engineering Co., Ltd.... 67
Hunt Bros. (Oldbury), Ltd..... 72

Ilford, Ltd..... 66
Imperial Chemical Industries, Ltd..... 98
Ince Forge Co..... 23
Industrial Fan and Heater Co., Ltd.....139
International Combustion, Ltd. 97
Ironsides Lubricants, Ltd.....126
Isca Foundry Co., Ltd..... 16

Kay, S., Rubber Co., Ltd..... 91
Keith, Charnock & Partners...136
Kelvin & Hughes (Industrial), Ltd.....104
Knight, Frank & Rutley.....137

Lafarge Aluminous Cement Co., Ltd.....42–117
Lang Pneumatic, Ltd..... 48
Lawrence Engineering Co., Ltd. 92
Leeds & Bradford Boiler Co., Ltd..... 75
Lewis Spring Co., Ltd.....138

PAGE

Leyland Motors, Ltd..... 34
Lincoln Electric Co., Ltd.....100
Lister, R. A., & Co., Ltd..... 47
Loveridge, Ltd..... 67
Low, A., & Sons, Ltd..... 2
Lucas, J. (Hydraulic & Combustion Equipment), Ltd..... 29

M.G.K. Engineering Co., Ltd. 20
MacLellan, P. & W., Ltd..... 47
McNeil, C., Ltd..... 43
Madan, C. S., & Co., Ltd..... 24
Main, A. & J., & Co., Ltd..... 48
Manganese Bronze & Brass Co., Ltd..... 99
Mason, E. N., & Sons, Ltd... 18
Mavor & Coulson, Ltd..... 96
Maxim Conveyors (England), Ltd..... 21
Measurement, Ltd. 124
Metalastik, Ltd..... 57
Metropolitan - Vickers Electrical Co., Ltd.. 103–112
Mills, W., Ltd..... 95
Mirrless Watson Co., Ltd..... 33
Morgan Crucible Co., Ltd..... 76
Morleys (B'ham, Ltd)..... 30
Munro, R. W., Ltd.....122

National Gas and Oil Engine Co., Ltd..... 54
Newall Group Sales, Ltd..... 89
Newton Sales Co., Ltd..... 90
Niagara Screens (Great Britain), Ltd..... 21
Nitralloy, Ltd..... 62
North British Rubber Co., Ltd.127

Oakey, J., & Sons, Ltd..... 27
Oil Feed Engineering Co., Ltd. 94
Oscard, J., & Co..... 70
Oxford University Press.....133

Parmiter, Hope & Sugden, Ltd. 81
Parsons, C. A., & Co., Ltd.....111
Paterson Engineering Co., Ltd. 68
Permoglaze, Ltd..... 94
Phillips, J. W. & C. J., Ltd.....126
Pinchin Johnson & Co..... 21
Plenty & Son, Ltd..... 65
Pollard Bearings, Ltd.....Cover iii
Positive Lock Washer Co., Ltd..... 14

PAGE

Pratt Bros. (Stourbridge), Ltd. 16
Priest Furnaces, Ltd..... 75

Ransomes & Rapier, Ltd. Cover i
Rayner, P., Ltd.....122
Reavell & Co., Ltd..... 62
Renold Chains, Ltd..... 32
Research Engineers, Ltd..... 23
Reyrolle, A., & Co., Ltd..... 46
Rice & Co. (Leeds), Ltd.....118
Richards & Partners.....137
Rivlink Belts, Ltd..... 23
Roberts, J. W., Ltd..... 70
Robertson & Ferguson, Ltd.... 5
Robson, G., & Co. (Conveyors), Ltd.....128
Rose, Downs & Thompson, Ltd..... 58
Rotherham & Sons, Ltd..... 23
Rotork Engineering Co., Ltd... 14
Russell, G., & Co., Ltd.....139
Russell, S., & Sons, Ltd..... 75

Sadi Engineering Co., Ltd..... 63
St. Georges Engineers, Ltd... 44
Sandwell Casting Co..... 47
Sankey, J., & Sons, Ltd.....123
Schieldrop & Co., Ltd..... 14
Schiess, A.G..... 59
Scottish Machine Tool Corporation, Ltd..... 72
Semtex, Ltd..... 19
Sheepbridge Equipment, Ltd.... 16
Simon-Carves, Ltd..... 61
Skerne Works, Ltd..... 87
Slick Brands, Ltd..... 48
Smedley Bros., Ltd..... 75
Smith, T., & Sons (Rodley), Ltd. 17
Smiths Clock & Watch Division105
Spencer (Melksham), Ltd..... 55
Spencer - Bonecourt - Clarkson, Ltd..... 88
Stamgo Manufacturing Co., Ltd..... 16
Standard Piston Ring & Engineering Co., Ltd.....105
Stanweld Engineering Co., Ltd.118
Stanley, W. F., & Co., Ltd..... 38
Steel Company of Scotland, Ltd..... 90
Steele & Cowlishaw, Ltd..... 91
Steels Engineering Products, Ltd..... 50

PAGE

Stone, J. B., & Co., Ltd..... 39
Stothert & Pitt, Ltd..... 40
Stubs, P., Ltd..... 69
Suffolk Iron Foundry (1920), Ltd..... 75
Sundwiger Eisenhütte..... 7
Sunvic Controls, Ltd..... 93

Tangyes, Ltd..... 68
Taylor & Challen, Ltd..... 35
Taylor & Hubbard, Ltd..... 65
Taylor, Taylor & Hobson, Ltd. 45
Teale, J. W., Ltd..... 75
Technological Institute of Gt. Britain.....131
Thermocontrol Installations, Co., Ltd..... 15
Thorn, J., & Sons, Ltd.....128
Tilghman's, Ltd..... 28
Tufnol, Ltd.....120
Turner Bros. Asbestos Co., Ltd..... 43

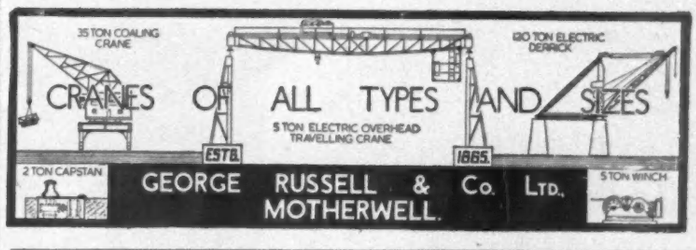
United Dominions Trust, Ltd.. 44
United Steel Companies, Ltd.... 77
United Steel Structural Co., Ltd. 77
Universal Conveyor Co., Ltd... 14

V.W. Co., Ltd.....128
Veritys, Ltd..... 64
Vickers - Armstrongs (Engineers), Ltd..... 9
Visco Engineering Co., Ltd.... 3
Vokes, Ltd..... 86
Vulcan Boiler & General Insurance Co., Ltd..... 90

Wailes, G., & Co., Ltd..... 69
Wallis & Co. (Millwall), Ltd.... 85
Ward, T. W., Ltd. 136
Wellman Bibby Co., Ltd..... 43
Wellman Smith Owen Engineering Corporation, Ltd.... 33
Wells, A. C., & Co., Ltd..... 27
Westinghouse Brake & Signal Co., Ltd..... 74
Westwood, J., & Co., Ltd..... 69
Wheatley Kirk, Price and Co.....137
Wilkinson Rubber Linatex, Ltd. 93

Yarrow & Co., Ltd..... 36

High Class GREY IRON CASTINGS
WHITE IRON AND NON - FERROUS
For all Engineering trades
★ To B.S.S. or customer's own specifications.
★ Floor moulded up to 5 tons.
★ Machined to your drawings if required.
The BRETTELL LANE FOUNDRY LIMITED
BRIERLEY HILL, STAFFORDSHIRE · Tel: BRIERLEY HILL 7254



RESISTANCE STRAIN GAUGES

By J. YARNELL, B.Sc., A.Inst.P.

Price 12s. 6d. *(Postage 6d.)*

This book deals with the construction and application of resistance strain gauges and with the most commonly used circuits and apparatus. The strain gauge rosette, which is finding ever wider application, is treated extensively, being introduced by a short exposition of the theory of stress and strain in a surface.

Order your copy through your Bookseller or direct from:—

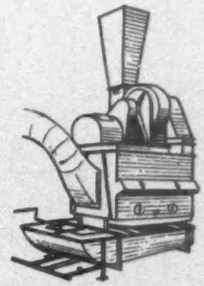
ELECTRONIC ENGINEERING 28, Essex Street, Strand, London, W.C.2.

P.V.C. FANS
Impervious to the chemical action of strong acids, alkalis and moist gases. Longer life reduces maintenance work.

DUST COLLECTING UNITS. Industry creates many types of dust but whatever your dust problem "Airflo" will solve it.

"Airflo" TRADE MARK

INDUSTRIAL SILENCING
For drop stamps, High Pressure blowers, Air noises on dust and Fume Plants. Easy to install.



WET DUST SETTLER
For handling fine dust up to 30 microns. Sludge deposited to outer tank. "Scumming" can be done from outside.

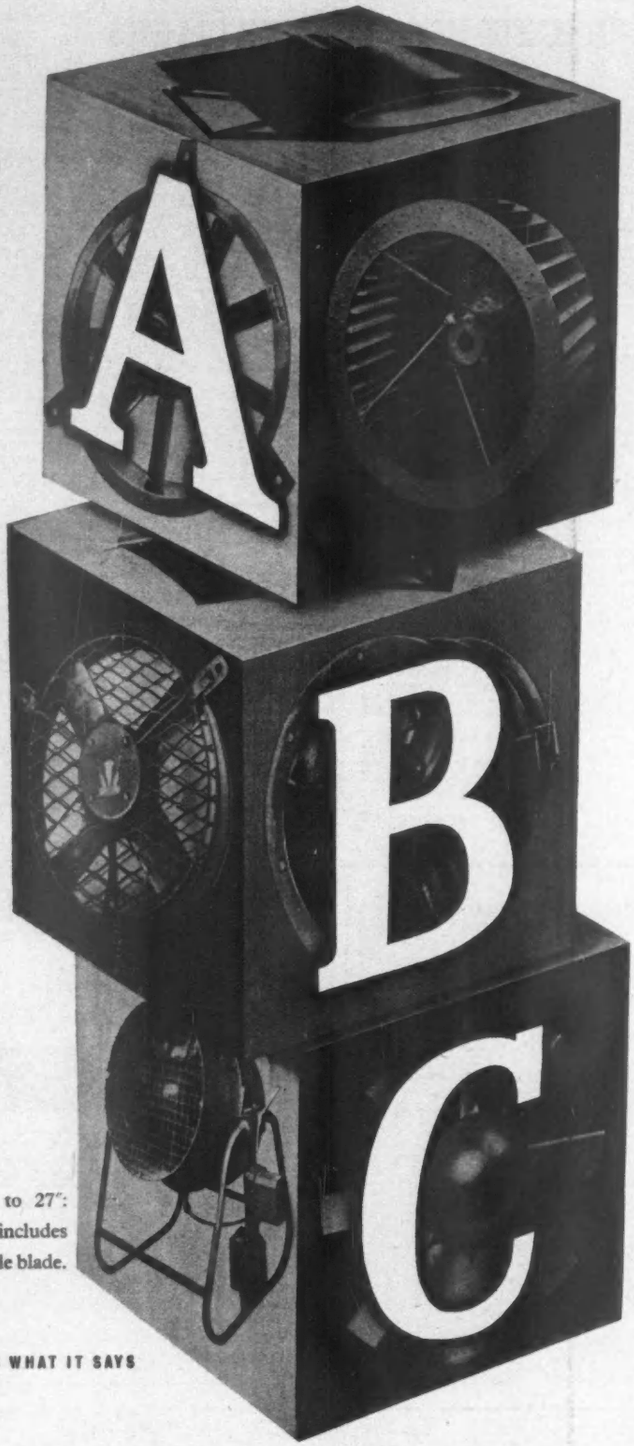
Industrial Fan & Heater Co Ltd

"Airflo" WORKS, BIRMINGHAM, 11. Phone: VICtoria 2277.

and at LONDON, MANCHESTER, SWANSEA, NEWCASTLE-UPON-TYNE.

A member of the SIMMS group.

Simple as



to select the right
FAN

The STANDARD AXIALS range 12″ to 27″: the STANDARD CENTRIFUGAL range includes forward curve, backward curve and paddle blade.

AN AIRSCREW SPECIFICATION MEANS WHAT IT SAYS

Airscrew can provide the right fan at the right time from their Standard range of Axial Flow and Centrifugal Fans.
The Airscrew Technical Service is ready to assist in fan selection from the Standard ranges or by special design when required.
Every Airscrew fan is guaranteed to give its rated duty.

AIRSCREW STANDARD FANS

THE AIRSCREW COMPANY & JICWOOD LTD · WEYBRIDGE · SURREY *Tel: Weybridge 2242/7*

PRINTED BY GEORGE REVERS, LTD., 10/12, ROSEBERY AVENUE, LONDON, E.C.1, FOR THE PROPRIETORS, MORGAN BROTHERS (PUBLISHERS), LTD., 28, ESSEX STREET, STRAND, LONDON, W.C.2. 7/1/0½

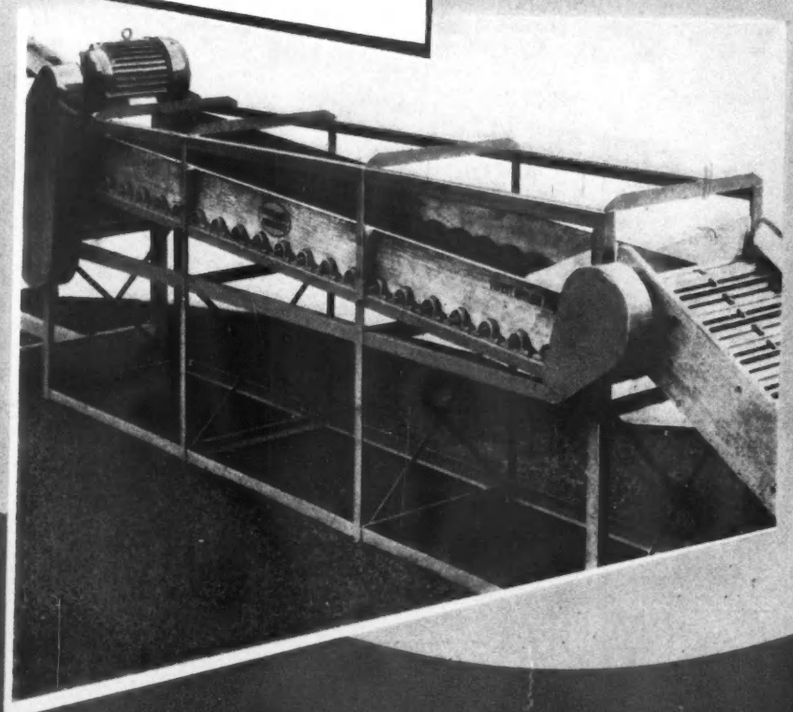
POLLARD Self-Lube

PILLOW BLOCKS AND BEARINGS

- ★ *Ball Bearing*
- ★ *Self - aligning*
- ★ *Self - lubricating*
- ★ *Self - sealing*

Require no attention throughout their life and are adaptable to most operating conditions.

ASK FOR CATALOGUE 'SL'



Quick reference catalogues also available for :—
Solid and Flexible Roller Bearings—'RFX'
'Max-Load' Roller Bearings—'ML'
Automobile Bearings—'CW'
Transmission Equipment—'TG'

Section of a potato dressing machine showing 'Self-Lube' pillow blocks. Photograph by courtesy of Messrs. Cooch and Sons, Northampton.

MAKE LIGHT OF HEAVY WORK

POLLARD BEARINGS LIMITED
FERRYBRIDGE, KNOTTINGLEY, YORKS. Tel.: Knottingley 2323. Telex: 55166.
LONDON OFFICE: 44 Hertford Street, W.1. Tel.: Legation 3368. Telex 23549
POLLARD BEARINGS (NORTHAMPTON) LTD., COUNTESS RD., NORTHAMPTON.
TEL: 3766. TELEX: 31624
CANADIAN POLLARD BEARINGS LIMITED, Oakville, Ontario. Tel.: VI.5-1667

The Engineer

JULY 11, 1958

ELECTROFLO-SMOOT

Automatic

BOILER

CONTROL

Fuel costs are high and steam remains industry's most expensive raw material.

One immediately practical, highly effective cost reducer is Electroflo Automatic Boiler Control.

It provides:

1. Higher capacity with safety.
2. Minimum fuel consumption.
3. Minimum air pollution.
4. Reduced maintenance costs.
5. Longer operating periods between overhauls.
6. Reduced labour charges.

The accompanying illustration shows the system applied to a Shell-type boiler—typical of many hundreds of installations on boilers of all types and capacities. Ask for Publication No. 8849.

Electroflo

ELECTROFLO METERS COMPANY LIMITED

Head Office: Abbey Road, Park Royal, London, N.W.10.

Factories: Abbey Road, Standard Road & Minerva Works, Chase Estate, Park Royal and Maryport, Cumberland

Telephone: Elgar 7641/8. *Grams & Cables:* Elflometa, London. *Telex:* Telex No. 2-3196

EA Member of Elliott-Automation Group